CHEMICAL ENGINEERING PROGRESS

# CEP

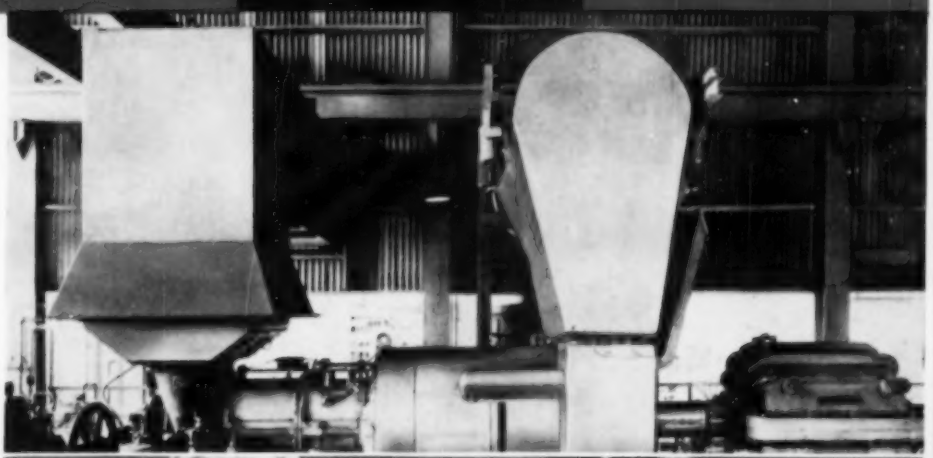
SEPTEMBER 1957

Will your new plant use a gas turbine? They are already saving a good many B.t.u.'s in the chemical industry, more applications are under way.

In any organization, superior-subordinate relations break down, decisions are resisted. Here's what to do.

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U. S. Patents 2,504,425—2,676,190—2,584,496.....Methionine for food supplements
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*Nothing herein shall constitute a recommendation to practice an invention covered by any patent without permission of the patent owner.

Chemical Engineering Progress

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September, 1957 • Volume 53, No. 9

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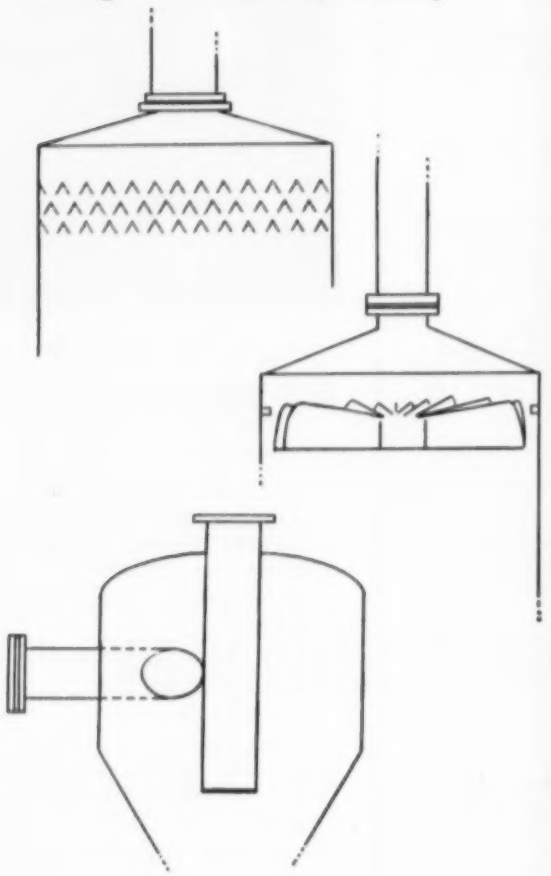
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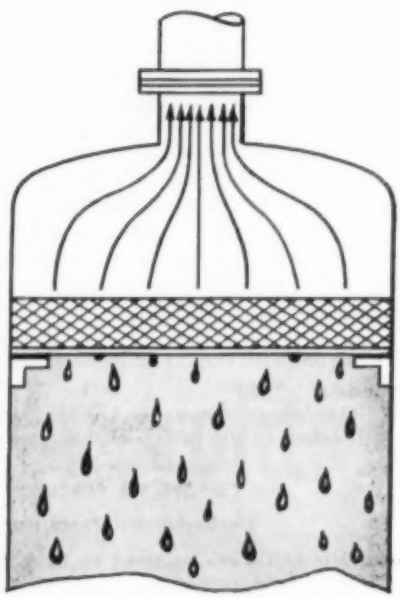
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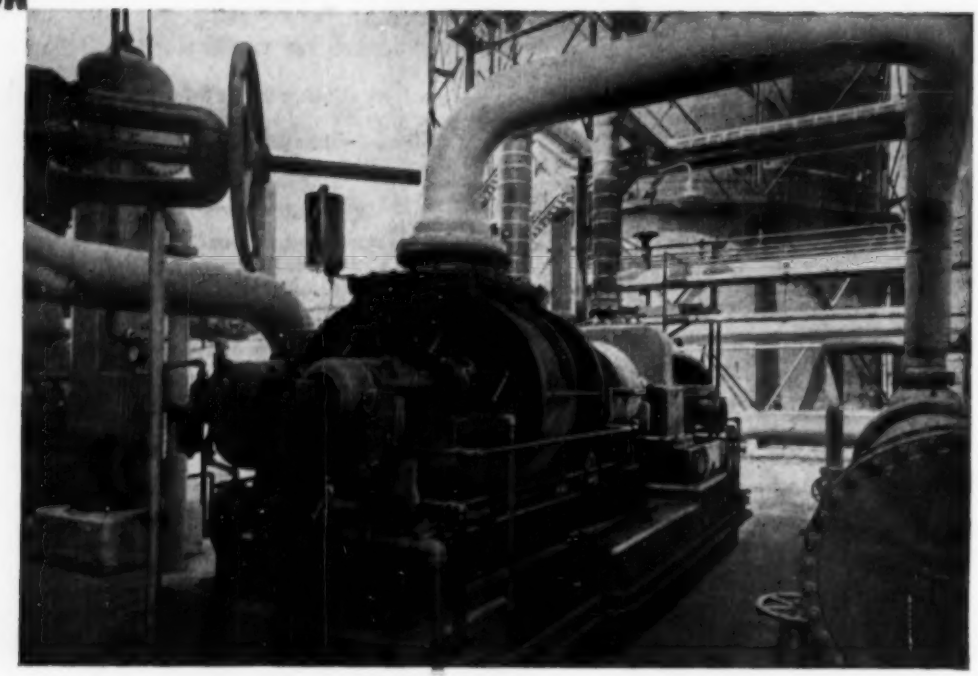
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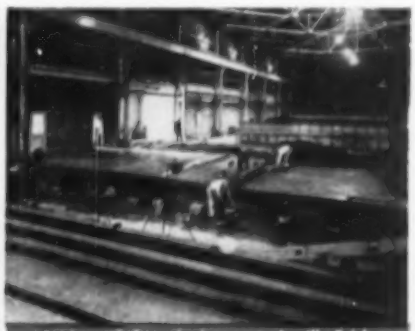
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Two views on

# MANAGEMENT'S RESPONSIBILITIES

## ■ PROGRESSIVE USE OF CAPITAL

*Leland I. Doan** | The Dow Chemical Company, Midland, Michigan

It is difficult nowadays to go into any sort of industrial gathering, or even to go about one's routine tasks, without encountering some discussion of management's "social responsibility," "corporate citizenship," or operation of business "in the public interest."

This preoccupation, however, is disturbing in that it is always possible to become myopic and allow the means to become an end. We have learned, sometimes the hard way, that business, if it is to be successful and enduring, must be operated *within the framework* of public interest. But I hope we never kid ourselves that we are operating *for* the public interest per se.

Our function is an economic one, and we have a very direct responsibility to carry out that function just as ably as we possibly can. Our social responsibilities are part of the package, but they are indirect. The main point is this: only so long as we do a good job in meeting our economic responsibilities are we going to be able to discharge our social ones.

Our first responsibility is profitable operation. That is the simple and perfectly honorable purpose underlying any economic endeavor. As employees of the owners it is our job to return a profit. We are custodians of their money, charged with the duty of seeing that it earns and grows. All our secondary responsibilities hinge on profit.

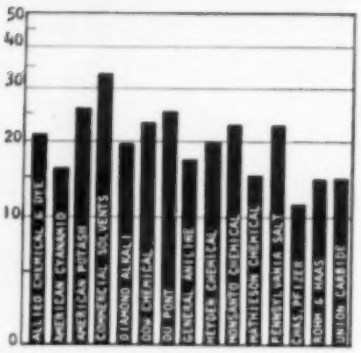
A second responsibility of management is protection of the owner's capital. The investor has a right to expect that when he places his money with us he is doing something better with it than simply putting it in a vault or burying it in a tin can. He should expect us to protect it in terms of purchasing power. If we fail to do that, then we have let his dollar depreciate just as though it had been buried.

(*Continued on page* 12)

* Mr. Doan is president of the company.

Condensed from an address before the 85th Annual Business Meeting, Manufacturing Chemists Association.

## Noted and quoted




Invested capital (in thousands of $) per employee in representative chemical companies as of December 31, 1956. "Invested capital" typically includes long term debt, common stock and surplus, any preferred stock, and all reserves except for depreciation and bad debts. (From material compiled by Stanford Research Institute.)

## ■ COMMUNICATING WITH EMPLOYEES

*Fred C. Foy* | Koppers Company, Inc.* Pittsburgh, Pennsylvania

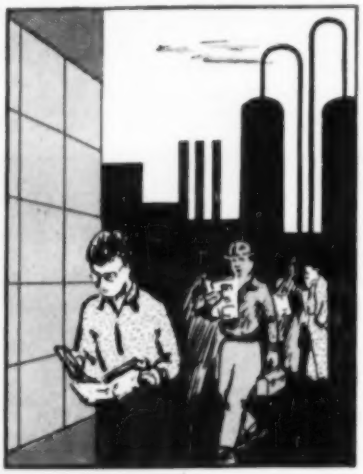
The future of America lies in the minds of men and in the vigor with which they pursue plans which public opinion holds to be right.

There are honest differences of opinion, but one of the tragedies is that too many are formed without proper knowledge of the facts. Thus, education becomes the prime factor in molding opinion, and where there are two sides to a question—and there usually are—the proponents and the opponents often line up in a battle to win the minds of men. Often these battles involve conflicting philosophies and the side which is the most vocal has the best chance of winning.

Today, labor and management have conflicting philosophies on many issues of importance. . . The economic system that employers believe in is vastly different from the economic system that would inevitably result from the adoption of programs advocated by some union leaders.

Both sides have assembled their arguments. Both sides have their economists and technicians preparing the evidence. Both sides are trying to get their views before key people. But, so far, we of management have elected to fight with one arm tied behind our backs.

Oh, we do a fine job of selling ourselves. In meetings such as this we hear speaker after speaker extol the virtues of the American economic system as it has developed under private enterprise. But from there on out it goes into low gear. Once outside the walls of these meeting rooms, many members of management are failing to use all of the resources at their fingertips which would help expose the economic fallacies propounded by some union leaders. Management is like the ostrich that theoretically hides its head in the sand at the first sign of danger. Management's conservatism and what seems to be a cautious, negative approach to controversial issues in telling its story to employees has created misunderstanding, even disloyalty, among the very people it wishes to influence most. And, by not doing the job we should do, we permit this antagonism toward management to spread. We permit, without challenge, the spreading of ideas which would hurt our businesses and the jobs of our employees.



What I can't understand is WHY only a few managements have taken steps in their communications program to be sure that their point of view on any controversial issue affecting both labor and industry is put directly before their own workers. Many managements have their company publications and in many ways they are good ones. Our surveys show that employees read them and believe them. Why don't we use them to present *logically* and *forcefully* management's ideas on these important subjects?

* Mr. Foy is president of the company.

Condensed from an address before the 85th Annual Business Meeting, Manufacturing Chemists Association.

# From Horse-radish... to Rocket Fuel...

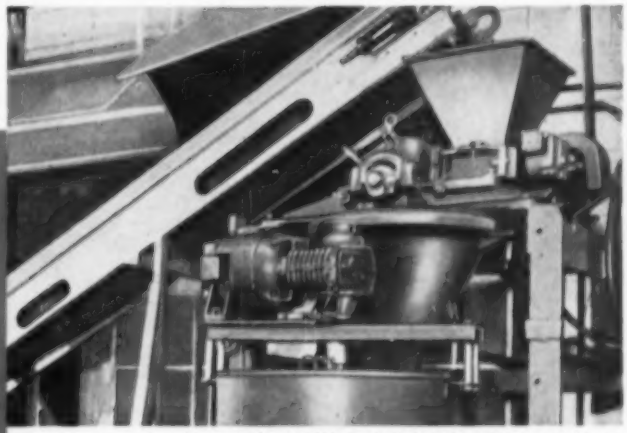




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BULLETIN 51A

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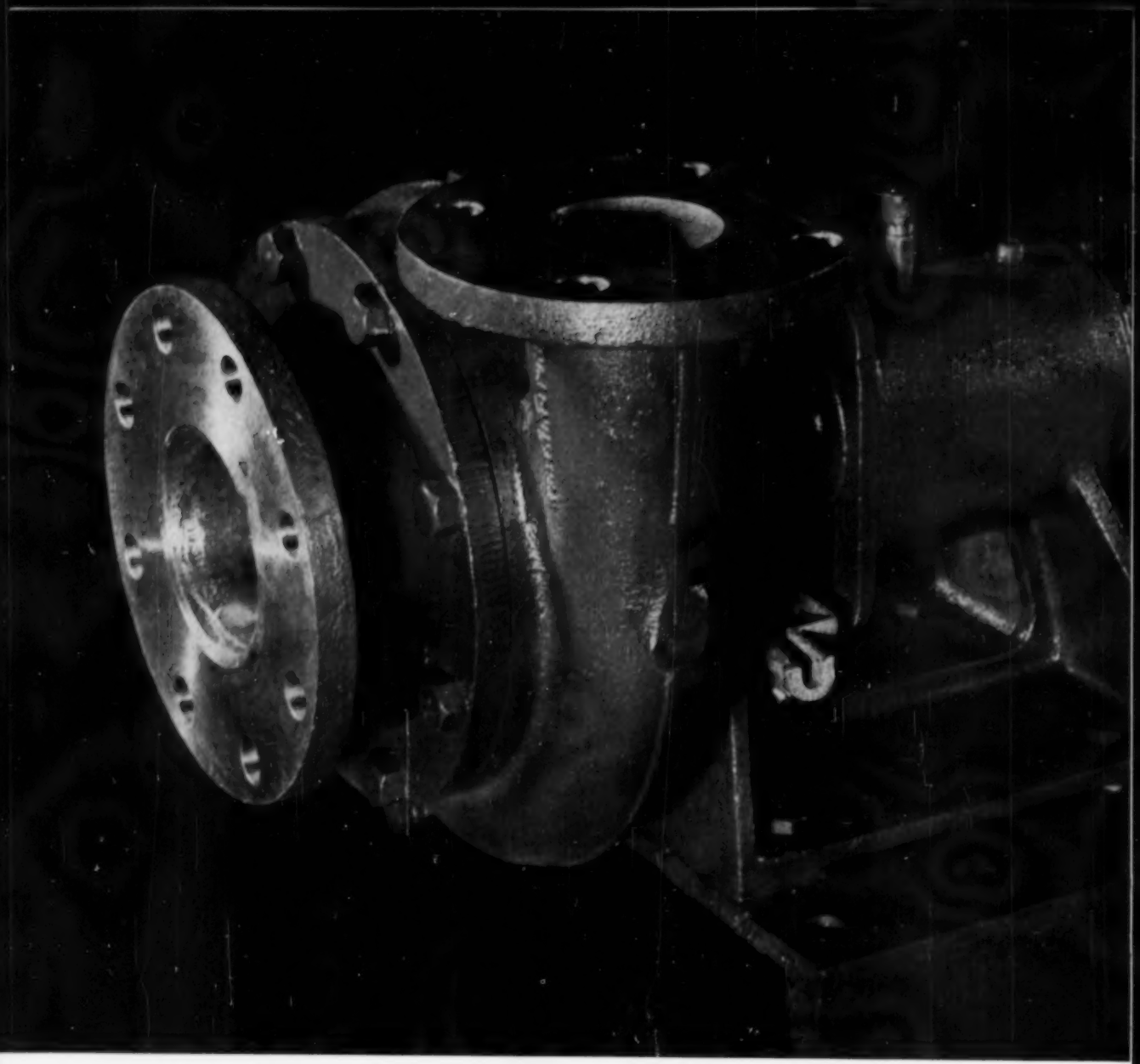
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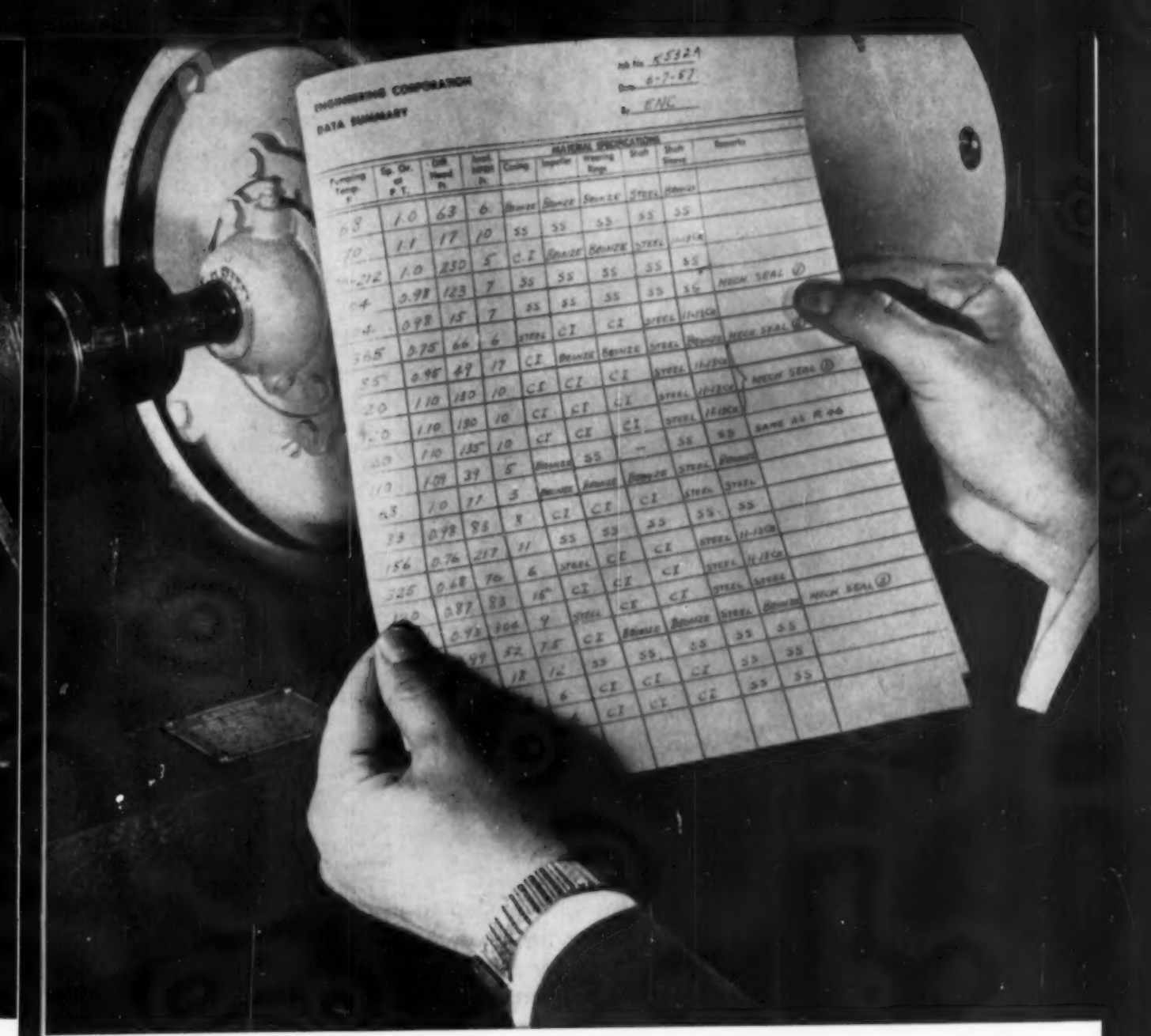
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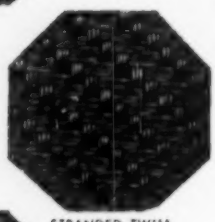
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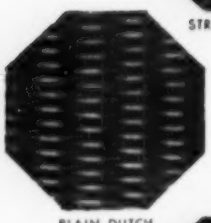
# Newark Metallic Filter Cloth . . .



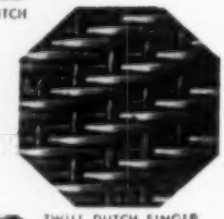


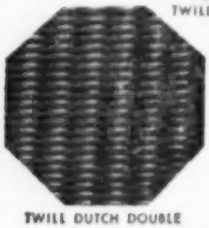
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## Noted and quoted

*(Continued from page 8)*

It is time both industrial management and government took into account some obvious facts of life which relate to this problem of depreciation.

First, our economy is not a static thing. It moves and changes. For many years we have had an inflationary economy and the purchasing power of the dollar has dwindled.

Secondly, corporate business tends to be perpetual in nature. We do not make an investment, recover it with whatever profit we can contrive, and then fold up our tents. By and large, the corporation goes on decade after decade and generation after generation.

**Since business is an enduring thing and lives in a changing economy, it seems that we are going to have to take a more realistic look at our tax structures and depreciation practices and make appropriate adjustments to assure business and industry the capital it needs for future growth and progress.**

Incentives for new venture capital have been declining and the more they decline the more we are going to have to look for other means of supporting the economic growth which the country inevitably must have. As managers of business it is our responsibility to do all that is in our power to see that the stockholder's slice does not become thinner. He has a right to expect this from us and, to face a very cold reality, the survival of capitalism as we now know it depends upon making individual investment in the corporate entity worthwhile.

Now, there is another responsibility of management that could well be regarded as both economic and social—the progressive and far-sighted use of capital and earnings.

In our competitive economy and ever-changing technology this is quite apt to be a necessity for survival. But it is not entirely axiomatic. I think there are many occasions when management could sit back, let things run along as they are, and return good profits for a long time.

We have seen much of this type of attitude in some segments of European industry. They deplore obsolescence and so are inclined to avoid it by simply not developing anything new. They like to do business "comfortably" and so they form alliances to split up markets and allocate production. Each is thereby assured profitable operation, but none has any particular incentive to improve process or product because it is not operating in a truly competitive situation.

*(Continued on page 16)*

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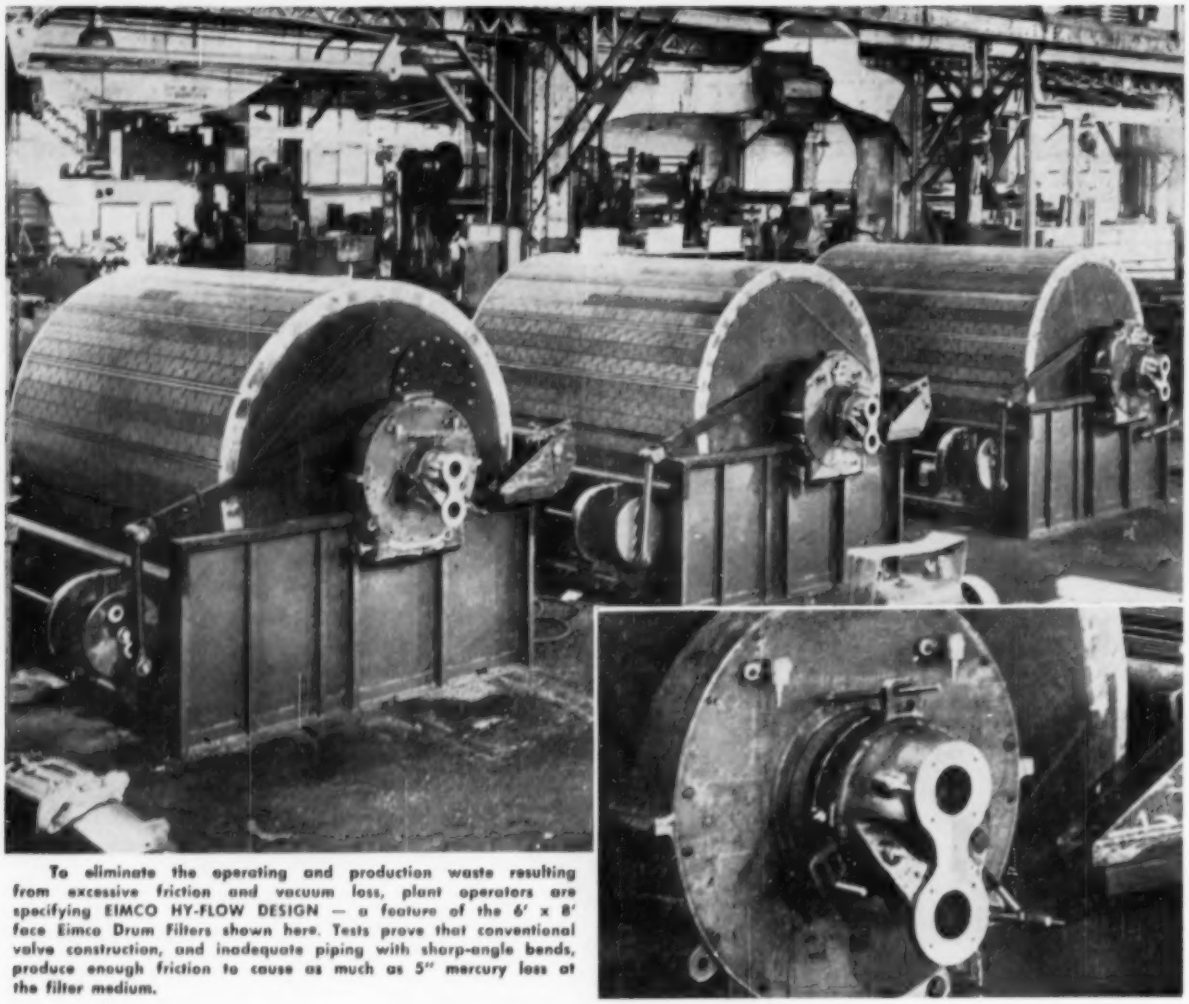
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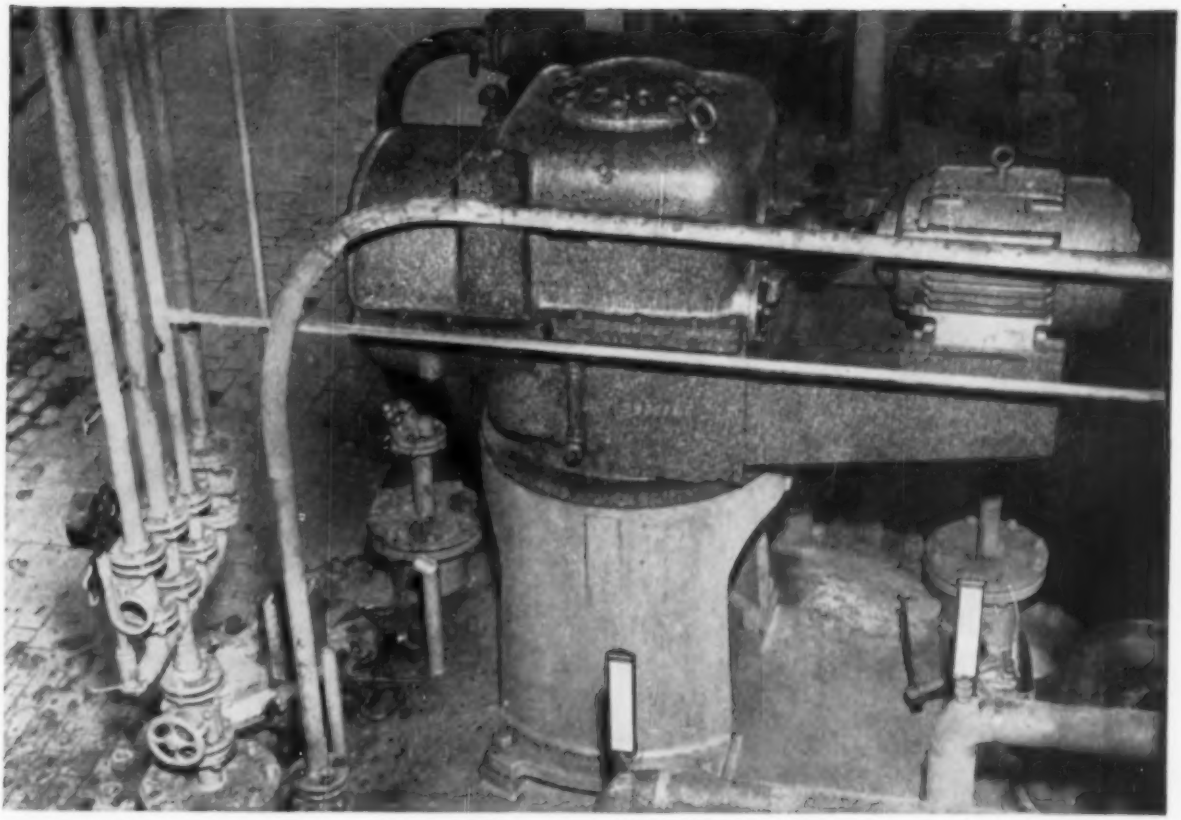
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B-284



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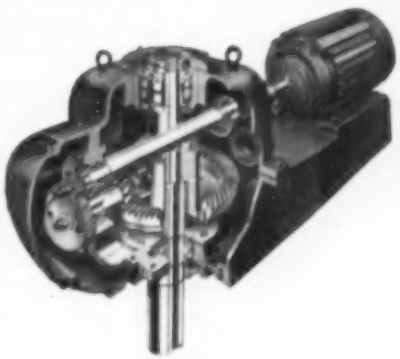
Their problem was twofold. First, to correctly mix sizeable quantities of highly corrosive material with abruptly changing viscosities without exceeding the rated capacity of the mixer drive. Secondly, to change motors and mixing speeds on the job readily and simply with minimum downtime expense.

The problem was quickly solved with the installation of a 3820 "packaged" Philadelphia Mixer. This mixer more than meets requirements for half speed operation at 7½ HP and full speed operation at 15 HP. Designed and built with generous service factors, the unit provides ample drive capacity for peak loads . . . assures long, quiet, trouble-free operation. All drives are AGMA rated.

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Philadelphia "packaged" Mixers are designed for maximum adaptability to all fluid Agitation applications. Standardization, high-production and complete control of all manufacturing by Phillie Gear assures you outstanding mixer performance at minimum cost.

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Philadelphia gear reducers for turbine and paddle-type fluid mixer drives have been meeting the most exacting specifications of major processors for many years. Because we now manufacture every major component of the new Philadelphia Fluid Mixers, except motors, bearings and mechanical seals, we offer the most integrated fluid mixer design, specifying, manufacturing and servicing facilities available.

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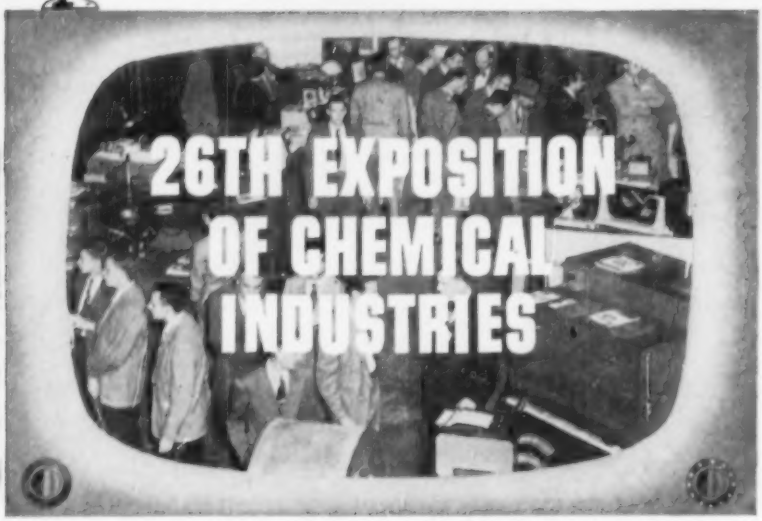
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## December 2-6, 1957

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**26th EXPOSITION OF CHEMICAL INDUSTRIES**
**NEW YORK COLISEUM, DECEMBER 2-6, 1957**

*Management:* International Exposition Company 480 Lexington Ave., New York 17, N. Y.


## Noted and quoted

(*Continued from page* 12)

These attitudes, this failure to accept a responsibility for progress, probably is a major reason much of Europe has lagged behind us technically and industrially. And because of this lag the European consumer lags behind us in standard of living.

Thus does energetic and progressive use of capital and earnings take on social implications. At the same time it adds to the value of the owner's holdings and the long-range return on his investment.

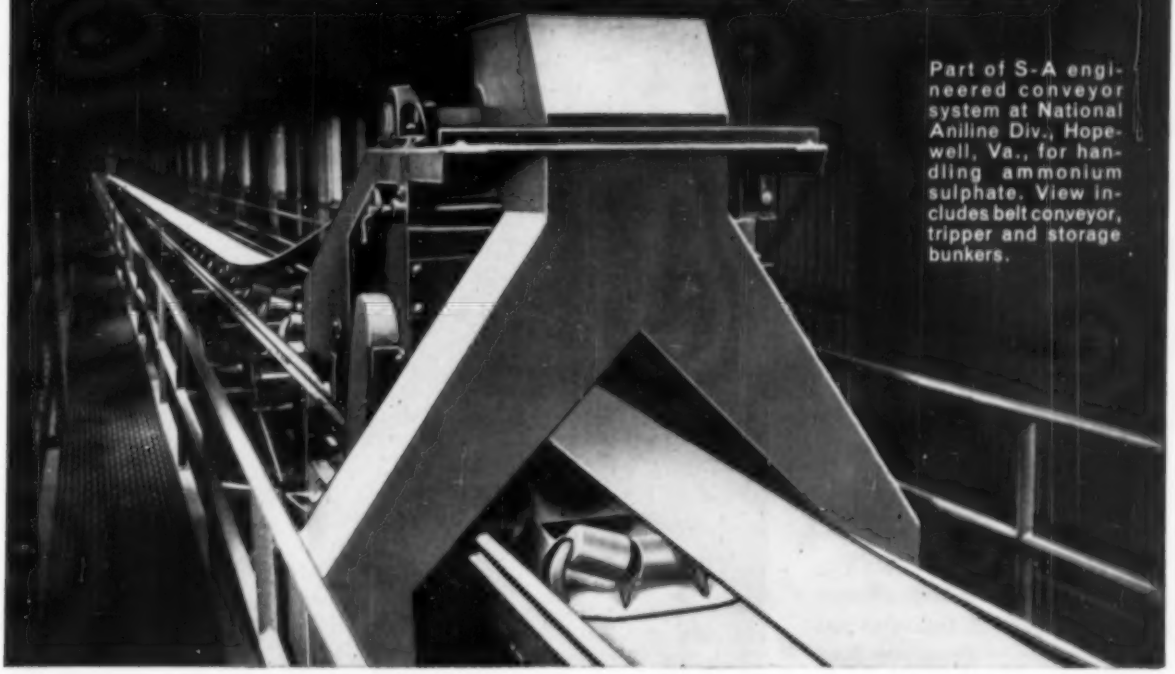
Research, of course, is the key. And it must be supported from earnings. We can continue research only so long as we make a profit, but we have a responsibility to see that a portion of our profit is so directed. We could all stop research tomorrow and we could then all give our stockholders some fat extra dividends. But in the long run they would be less well off, and to that degree we would be shirking an economic responsibility. We would, at the same time, be shirking a primary social responsibility.

We have only to look about us to recognize that industry, through its research, has been responsible for most of the physical progress that our civilization has made. It pours millions of dollars into the development of new products, better ways of doing things, with the profits from already successful products picking up the check until, ultimately, the new product is able to stand on its own feet and return its own profit.

Many, of course, never do pay off, but the net result of the system improves our civilization, benefits everyone—the owners, the employees, the consumers. None of the things which we rather take for granted—the drugs, the fibers, the plastics and so on—would have been brought about if industrial management had not accepted that dual economic and social responsibility.

We are now just in the early stages of what everyone seems to refer to lightly as the "atomic age." We don't have any idea what the atomic age is. It is too early in the game. We have just discovered a few new things about the atom that have opened up great new vistas of potentiality. Industry cannot claim sole credit for the basic discoveries. But I am sure of one thing—that the fruits of atomic energy, the "atomic age," whatever it turns out to be, will be brought about only through industrial management pouring heaven knows how many millions into this new area of exploration.

# STEPHENS ADAMSON



Part of S-A engineered conveyor system at National Aniline Div., Hopewell, Va., for handling ammonium sulphate. View includes belt conveyor, tripper and storage bunkers.

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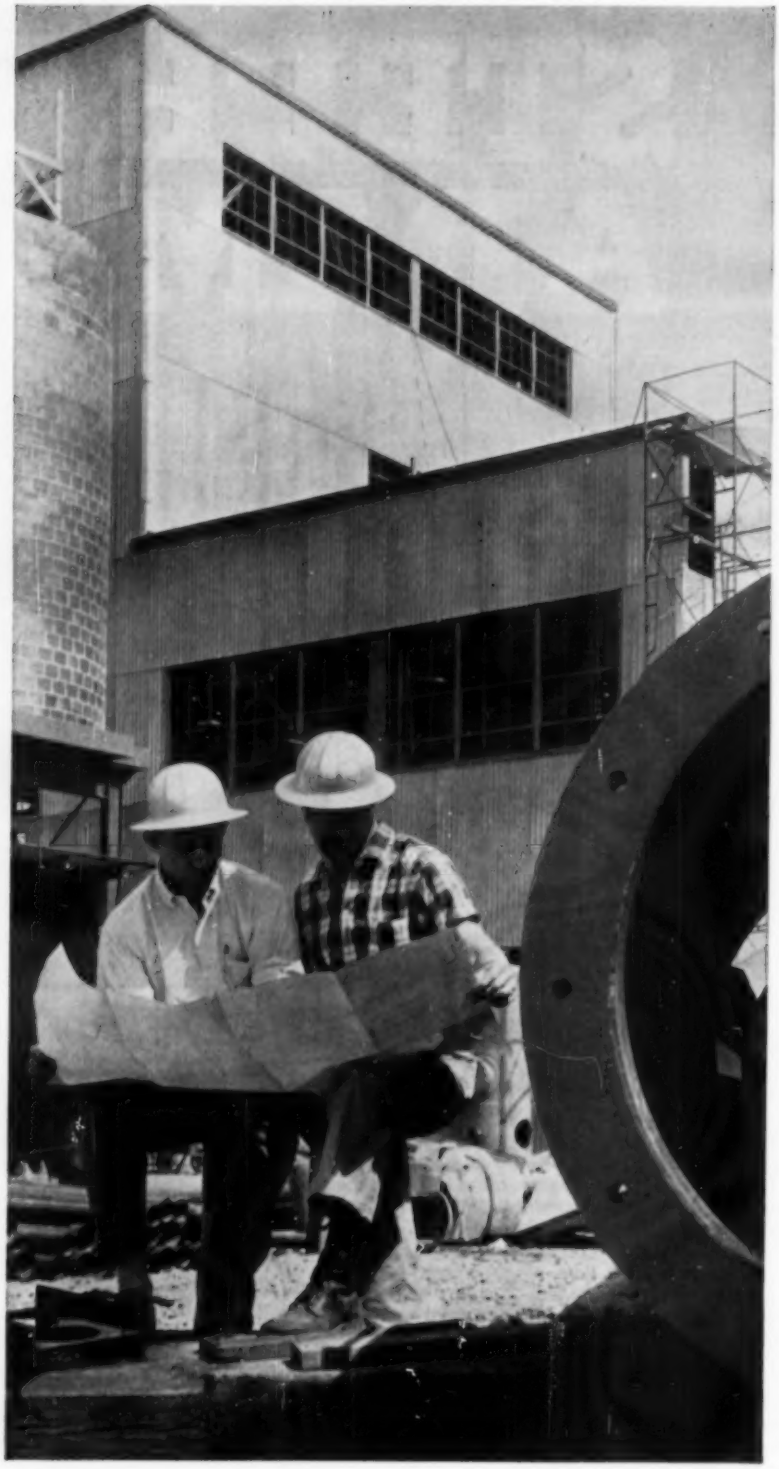
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TAKING
THE PULSE OF
SUPERIOR-SUBORDINATE
RELATIONSHIPS AND

# TRANSLATING DECISIONS INTO ACTION

*Elbert W. Burr* | Monsanto Chemical Company, St. Louis, Missouri

**The following comments on the problem of translating decisions into action are offered to arouse an industrial manager's awareness of the many facets of decision-making and, in turn, to stimulate thoughtful consideration by chemical engineers of the difficulty facing management in all companies in arriving at good decisions and in making them work. Neither a technical report nor a psychological analysis of the problem, this article takes account of the findings of some of the current studies of leadership and group behavior.**

Those who are a part of the main stream of the industrial organization know from experience that management decisions made in good faith, based on adequate data, and tested for validity against previous experience still all too frequently do not lead to effective action. It is this problem of making certain that the actions required to implement decisions are taken in a productive and profitable way that requires the attention of every progressive manager.

Although decision-making situations are varied and often unique, it is helpful in analyzing them to mark off four particular phases: namely, (1) the existence of the condition or situation which requires the decision, (2) the decision itself (and this phase includes the various activities associated with simple decision-making), (3) the action taken as a result of the decision, (4) the evaluation.

Whereas the concern here is particularly with the way in which the action required by the decision is planned and carried out, it is obvious that in any effective study one phase of the problem cannot be isolated from the other phases. Planning the strategy of the action depends upon the skill with which other phases of the process are carried out. This suggests that a *good* decision can be made only after the action to follow has been planned in such a way that its effectiveness is assured. It further suggests that on most occasions the very nature of the decision itself is, in a major way, shaped by the actions necessary to implement that decision.

### Individual and Group Morale

The manager who is skilled in decision-making takes into account both the ability of individuals to perform in the way the decision demands and also the complexity of organizational and social relationships. The abilities of individuals to perform, however, are more likely to be known to managers than are their current feelings and attitudes. Studies of these feelings indicate the importance of the morale of the organization to the success with which action steps can be taken. Where morale is high and the avenues of communication in matters of plans, policies, and procedures are open and clear, it is usually easier to accomplish the changes necessary in the behavior of individuals to assure the level of performance required by the decision. It is also important to note that morale within the work group influences (and as well is influenced by) the ability of managers to make good decisions and to implement those decisions successfully. Thus, then, there is much more to translating decisions into action than the simple "order giving" which was once found in some segments of our industrial life.

### Resisting Decisions

Even under the most favorable conditions however, decisions requiring changes in people do meet resistances. Actual behavior and/or performance on the job often defeats or distorts the intent of the decision. All too frequently good decisions cannot be carried into effective action because managers do not recognize the forces that make people resist reasonable changes.

#### REASONS

There are many reasons advanced for resistance to change on the part of individuals. Among these are:

1. **loss of prestige**
2. **the threat to economic security**
3. **fear of inadequacy in a new job situation**
4. **fear of being too old to learn the new skills required, especially when one has not maintained his learning skills**
5. **fear caused by the disruption of the social structure of the job situation.**

Each of these has particular significance when viewed in the light of individual motivation and of the factors which are known to contribute to a general sense of well-being. Perhaps the most difficult to understand is the

Mr. Burr is manager of Personnel Development.

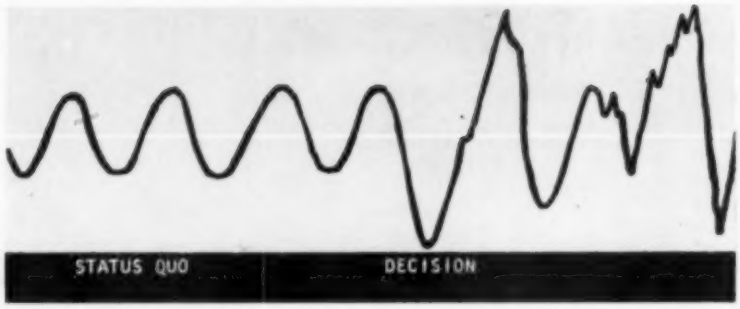
feeling which apparently stems from the disruption of the work group and the consequent reduction in individual job satisfaction. Current study of this problem indicates that people seem to look to the stability of the work force as a partial source of their individual job security. Resistances to enforced change in the work group are sometimes so strong that they can disrupt an entire organization and effectively block a change in procedures which on technical grounds is completely sound.

Even more significant may be the resistance of people to *being* changed. It is becoming increasingly evident that people resist being pushed or shoved into a situation involving changes in group structure or work procedures. They tend to resist the activities of others—especially their superiors—which manipulate and structure the work environment so that it appears to have lost its atmosphere of security and comfortableness. When they are not given an opportunity to influence the new design of the work group or to help to determine the process by which change is to be achieved, they may well demonstrate sullen resentment or even overt rebellion. It is such resistance to change which is frequently not understood by the manager and not adequately considered when plans are made to implement his decisions. It may well be that the continued acceleration of technological change is in some ways dependent on the manager's ability to cope with such resistances.

If one accepts the importance of the organizational and social relationships in the situation into which change is being introduced, he should then develop greater sensitivity to the cues which indicate resistance. These may be observed in any situation in which changes in behavior are required. The point in the organization at which these cues to resistance may be most easily observed and dealt with seems to be the superior-subordinate relationship. In this relationship, an excellent opportunity is presented to observe resistance to change and to plan a strategy for overcoming it.

#### The Breakdown in Human Relations

A look at events as they occur in this relationship highlights the problem. When the decision is made by the superior, the pressure is on him to accomplish the action—to facilitate the changes in individual behavior now required. As an individual, however, he realizes that, with the making of the decision, he has assumed new responsibilities. He, of necessity, becomes involved with the problem of accomplishing results to the point that he may narrow the range of his normal contacts with his people. He may occasionally respond to these pressures by taking summary and arbitrary actions in supervising their work which he might not customarily take.



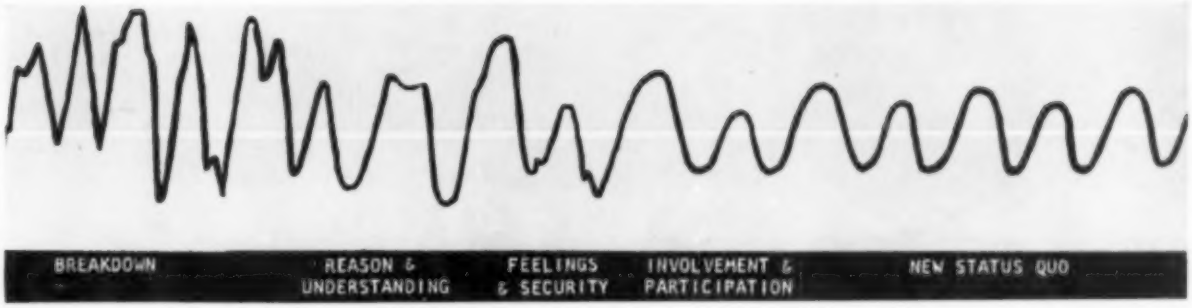

Those who worked with him in the days before his new commitment to action initially continue to work to achieve these new goals much as they have in the past. But it often becomes evident to them that he is so increasingly preoccupied that daily interpersonal relationships suffer beyond repair. The old time security is no longer valid. Some of them even come to feel that he now sees them in a different light, that their relationship is completely changed and that it now is determined by their ability to achieve *his* objective. This tends to nurture their resistances to the changes which have caused his seemingly new behavior. It may well bring about compensating behavior on their part, either individually or collectively, which militates against his success.

The significance in this breakdown in the superior-subordinate relationship cannot be overemphasized. Almost every investigation of the elements of job satisfaction shows that the security of the individual in the superior-subordinate relationship is close to the top of the scale of employee values. Is it any wonder then that resistance to change occurs when the pressure-driven superior behaves in such a way that he threatens the security which that relationship, when effective, gives to the subordinate? When the atmosphere of approval of subordinate performance becomes one of disapproval because performance is not as effective as the superior feels the situation demands, the subordinate loses confidence in the relationship and tends to perform even less effectively. This resistance may be even stronger and performance even less effective when the subordinates share in a closely knit social structure—one in which group activities, group cohesiveness, and group dependency result in an informal yet partially organized resistance to change. This poses an especially difficult problem because both the superior-subordinate relationship and the larger social structure are now involved.

What now can be done to effect the success of the manager's efforts to change the behavior of individuals and to assign them work in different work groups? Possible approaches in three rather general and by no means mutually exclusive categories are: (1) reasons and understanding, (2) feelings and security, and (3) involvement and participation.

#### 1. Reasons and Understanding

Every effort that is made in industrial organizations to translate decisions into action requires informing people of steps that are being taken. The more an individual knows about the work situation, the problems faced by the organization, the nature of his part in their solution, the better prepared he is to accept as necessary those decisions which are made—even those which seem to affect him adversely—just as in a broader sense most people want to know what is happening to the world they live in, especially that part of it which they experience each day. Their need for information is a continuing one. Knowledge of a total situation is essential before they can understand the specifics of the phase which requires the decision involving changes in their behavior. In decision-making, then, the more opportunity the individual has to think over the relationship of his goals, his status, his motivations to changes resulting from the decision, the better able he is to live successfully with new conditions. Good com-




munication is vital to making good decisions work.

#### 2. *Feelings and Security*

Each man has more or less a selfish interest in his own life and in his own future. To know what given changes in the work situation mean to him is something each man feels he has a right to know. The greater the degree to which he can analyze and apply these changes to his own situation the more adaptable he will be to change. When he knows what may happen to him as a result of a decision, he can freely choose his own course of action. He can to some degree manipulate his environment as opposed to being manipulated by it.

Thus, during periods of change the individual may often require more personal attention than the usual measure of support and assurance from his superior. He may require added opportunities to discuss changes with his associates. If the superior is so pressed by his desire to achieve results that he no longer feels able himself to give this time-consuming support to his subordinate, he may make constructive use of long service and unusually secure employees to act as "interpreters of change." Such individuals may even be more helpful than the superior in talking with those whose feelings of resistance result from worry over the effect of changes in the relationship with their community. An important fact often overlooked is that changes in job responsibilities have their overtones in the neighborhood social structure. And all too often superiors are so engrossed with the changes being introduced in the laboratory or the plant that they give scant attention to these external matters which often create added resistance to change.

#### 3. *Involvement and Participation*

A frequently discussed problem in management philosophy today is that of participation in decision-making—how much, when, how? Research indicates that participation and involvement in the process of decision-making tend to improve the success of action required. The subordinate's development is enhanced by the opportunities he has to create independent ideas, to express them, and to participate in discussions in which their soundness is tested. His participation, in an atmosphere of security and approval from his superior, not only gives him the satisfaction of being informed in advance about changes contemplated but it also offers him an opportunity to bring his creative energies to bear on the tough problems faced by his superiors in decision making.

Studies, including a number of researches in group involvement, have indicated the value of such group participation in reducing resistance to change in an industrial organization.

There are those who feel that where leadership is gifted and authority and responsibility clearly defined, participation in any extensive degree tends to interfere with the effectiveness of management decision-making. Studies of resistance to change suggest, however, that even in those situations in which "right" decisions are being made by such a manager without participation by his subordinates, there is value to be found in encouraging a group review of action steps—objections or approval—and the opportunity to work through the specific plans to effect the action required by the decision. Since many resistances to change can be aired and possibly dealt with in such a group situation, the superior who uses this group approach may find a way to modify decisions already tentatively made so that more effective action will result. Whatever approach is used in making the decision, it must be said that involvement and participation in its translation into action contribute in an important way to its success.

#### The Human Equation

These are complex problems. Additional basic research in human behavior, in managerial performance, and in work-group structure is badly needed. A willingness on the part of individual managers to analyze and evaluate their own decision-making activities may shed new light on certain phases of these problems. A greater effort made to train managers in decision-making and in the skills necessary to translate decisions into action will help. But only when management devotes the same skill and precision to the study of the human side of its problems as it now devotes to the technical phases of research, engineering, and production will important progress be recorded in the improvement of management decision-making.

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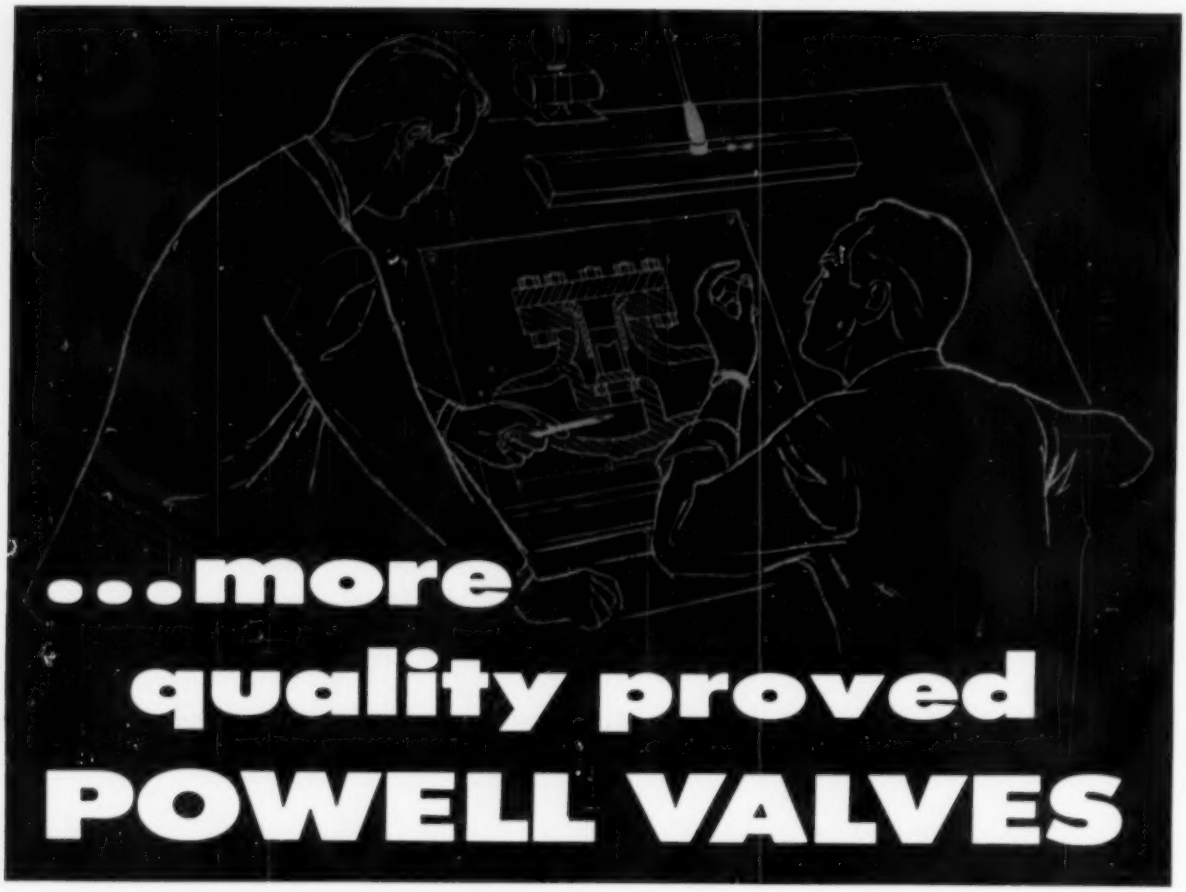
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*Presented at A.I.Ch.E. meeting, White Sulphur Springs, West Virginia.*



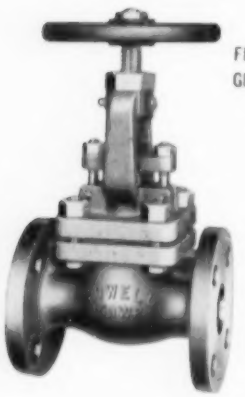



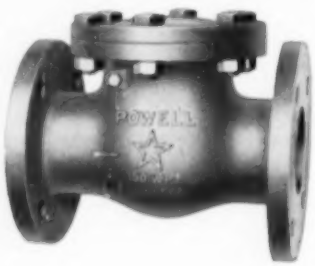
FIG. 2475—Stainless Steel O.S. & Y. Globe Valve for 150 Pounds W.P.

FIG. 2309 SW—150-Pound Flush Bottom Tank Valve with Powell Patented Seat Wiper.



FIG. 2456 SG—Large Stainless Steel Gate Valve for 150 Pounds W. P. Flanges conform to latest Standards.

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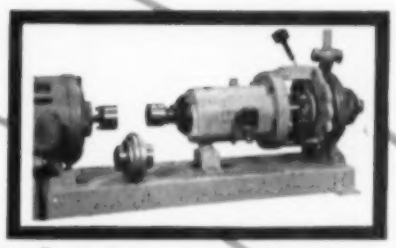


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# Marginal notes




## New Correlations of Unit Operations

*Unit Operations of Chemical Engineering*, Warren L. McCabe and Julian C. Smith. McGraw-Hill Book Company, Inc. New York (1956), 945 p., $10.50.

*Reviewed by Stanford W. Briggs, Department of Chemical Engineering, Purdue University, Lafayette, Indiana.*

McCabe and Smith's new book is probably the best on chemical engineering unit operations currently available. It is well written and fairly comprehensive. The practicing engineer will find the book particularly useful. To some extent it will take the place of a handbook.

Transportation of fluids and fluid mechanics are treated in separate chapters. This separation helps the reader avoid confusing the basic theory of fluid mechanics with diverse (although important) matters such as the description of pipes, fittings, valves and pumps and the theory of pumps, and it helps the practicing engineer locate specific practical information which he may need. In the chapter on mixing, relatively too much space is given to the subject of flow patterns obtained with mixers. Some of the diagrams show techniques which are no longer in use. The parts of the chapter dealing with scale-up and power consumption are accurate and up-to-date. The chapter dealing with mechanical separation is excellent from the viewpoint of the practicing engineer.

The order in which topics are presented is at times unconventional. Such things as viscosity, boundary layer, Hagen-Poiseuille equation, Reynolds number, and velocity distribution are discussed before the Bernouilli equation. Unsteady-state heat transfer comes between heat transfer to boiling liquids and heat exchange equipment. The correlation of friction loss on sudden expansion in the fluid mechanics chapter is unsatisfactory. It gives negative values over a rather wide range of conditions.

In the chapter on flow of heat, the temperature vs. length curves for heat exchangers help the student in his understanding of what goes on in the equipment. Evaporation is properly presented as a special case of heat transfer. The section on vapor recompression probably should be expanded because of the interest in wider expansion of this technique in the fields of evaporation and distillation.

The general organization of the chapters on mass transfer operations is satisfactory. An explanation of the Reynolds analogy would have been desirable in order to make the student's basic understanding of chemical engineering operations more sound. The use of mole fraction rather than mole ratio for absorption column calculations is commendable. The chapter on distillation is quite good. The chapter on leaching and extraction probably should have given more attention to extraction column calculations.

For teaching purposes the text has a characteristic common to most other chemical engineering unit operations texts. It covers more ground than can be properly taught in a two-semester undergraduate course.

## Ion Exchange From A to Z

*Synthetic Ion Exchangers*, G. H. Osborn, The Macmillan Co., New York, text 85 p., bibliography 103 p. (1956), $6.00.

*Reviewed by R. M. Wheaton, Physical Research Laboratory, The Dow Chemical Company, Midland, Michigan.*

The principal value of this book is in its extensive bibliography and index. The work covers ion exchange theory and applications from acetates, through bacteriology and cadmium, to zirconium.

To quote from the author's preface: "The rest of the book is . . . devoted to a discussion of the latest types of resins available, and also to a discussion of the latest techniques now being proposed for the use of these resins, some of which are of great interest and potentiality."

Included in the book are chapters on the structure, preparation, and properties of ion exchange resins; performance data on commercial resins; analytical aspects; reactions with materials of low solubility; ion exclusion; ion exchange membranes; and therapeutic applications.

To one wishing to explore ion exchange or related fields, the book must be considered an introduction—it is brief and, in some cases, oversimplified. There are many broad statements which could be misinterpreted.

The chapter devoted to performance data of ion exchange resins goes a long way toward elimination of confusion with respect to various trade products. Much information is lacking and general organization is not good. The chapters dealing with the newer applications of ion exchange materials briefly scan the field, provide basic information, and should serve to interest one in furthering his ion exchange investigations. The information on membranes and ion exclusion is well presented, although everybody won't share the author's pessimism with respect to the industrial potentialities of the latter.

## A Manual of Problems

*Chemical Engineering Laboratory Problems*, H. Clay Lewis, School of Chemical Engineering, Georgia Institute of Technology, Atlanta, Georgia, (1957), 46 p.

*Reviewed by E. B. Chiswell, California Research Corporation, Richmond, California.*

This work, to all intents and purposes a problem manual, makes an important contribution with its emphasis on ingenuity in designing and performing experiments. In a laboratory equipped for such experimental work, satisfactory results can undoubtedly be achieved. However, it is just possible that a full course of problems of this type would result in too great an emphasis on equipment design, accumulation, and assembly. Certainly, a few problems of the type described here would be refreshing in any unit operations work. Generally, the experiments are well thought out albeit a few appear quite elementary. Possibly another problem in the section entitled "absorption" could be designed to illustrate more thoroughly this unit operation.

The booklet is also a worth-while contribution to those interested in chemical engineering education and should be of value to them for a good many years.

## Personality of the American Engineer

*A Profile of the Engineer*, Industrial Relations News, New York, series of three reports, $7.50.

A detailed portrait of the American engineer—his intelligence and abilities, his distinctive personality traits, social attitudes, work habits, and recreational interests.

(Continued on page 26)

# Industry gets tons of oxygen ...*with no capital investment*

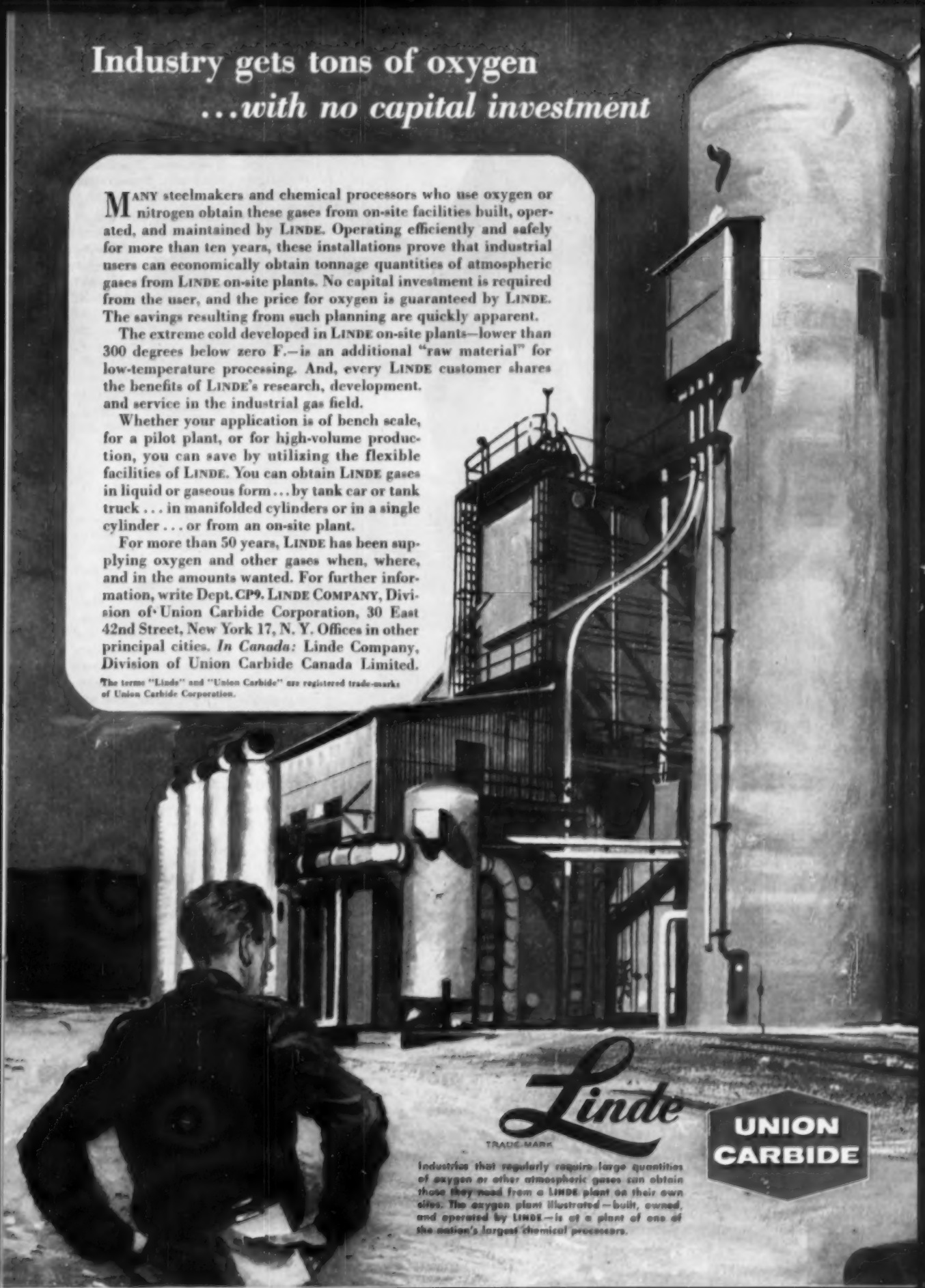
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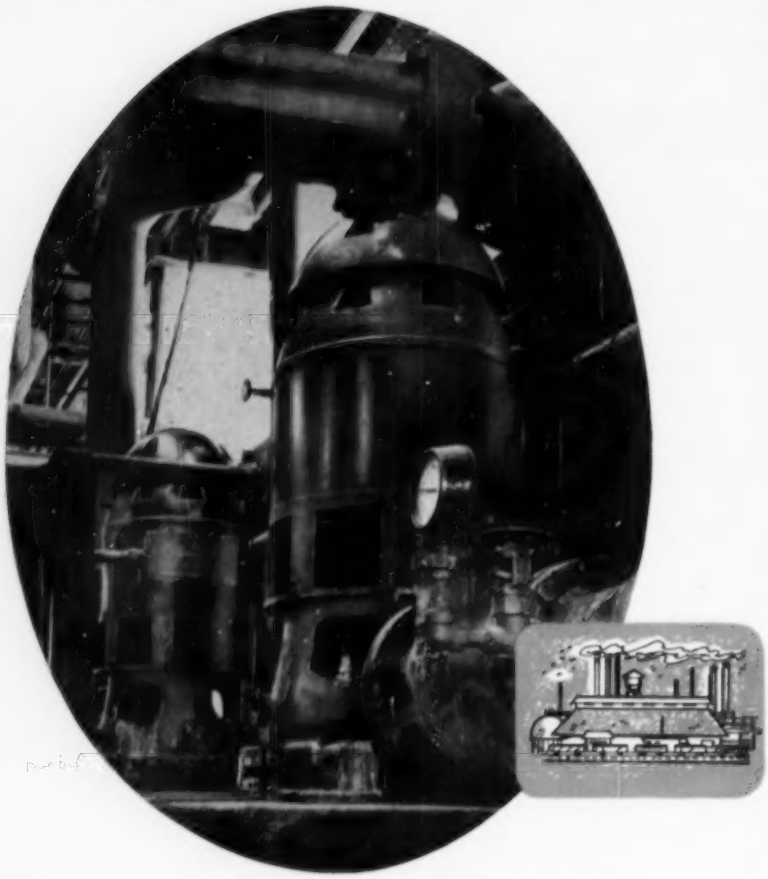
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# Marginal notes

(*Continued from page 24*)

## A General Clean-Up

*Proceedings of the Cleaner Air for Urban Areas Symposium.* The Franklin Institute, Philadelphia, Pennsylvania. 69 p. + iii (1956), $3.00 each.

The volume contains transcripts of talks presented by Francois N. Frenkiel—Air Pollution in the Growing Community; Harry Heimann—Air Pollution and Community Health; William E. Scott and Edgar R. Stephens—A Scientific Approach to the Problem; Arie Jan Haagen-Smit—The Chemist in the Community; Leonard Greenburg, M.D.—The Official Agency in Air Pollution Control; W. H. Claussen—Industry Acts to Control Air Pollution; and W. C. L. Hemeon—Industrial Mobilization for Air Pollution Control.

## Playing Safe

*Chemical Safety Data Sheet SD-25, Hydrofluoric Acid.* Manufacturing Chemists' Association, Inc., Washington, D. C. (1957), 46 pages, 50 cents.

This revised safety booklet is part of a continuing MCA series of safety data sheets. It includes twelve illustrations and special, detailed instructions pertaining to the handling and emptying of cylinders and tank cars containing hydrofluoric acid. There are also sections on hazards, engineering controls, employee safety, tank and equipment maintenance, waste disposal, medical management, and first aid.

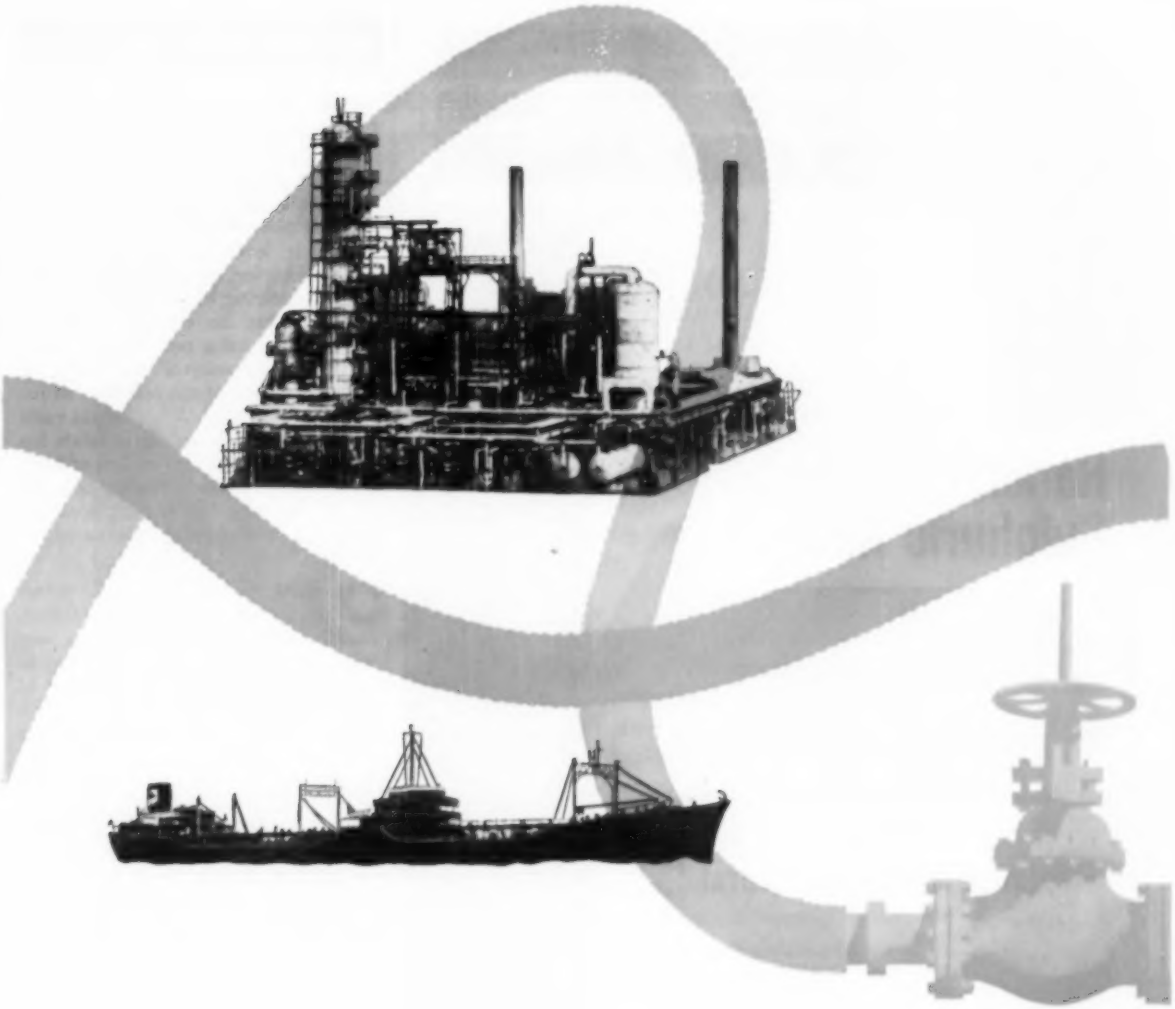
## Combustion of Gaseous Fuels

*Fundamentals of Combustion of Gaseous Fuels—A Critical Literature Review,* S. A. Weil, R. T. Ellington, E. F. Scaright, and S. Hu, (Research Bulletin No. 15), Institute of Gas Technology, Illinois Institute of Technology, 63 p., $5.00.

Sponsored by the General Research Planning Committee of the American Gas Association, this is an exhaustive listing of the literature on the theory of combustion, combustion phenomena, experimental investigations of various phases of combustion, and certain fundamentals of particular importance to burner design.

## Water Supply Treatment (Bulletin 211)

Eighth edition prepared by Merrill L. Riehl. Published by National Lime Association, Washington, D.C. (1957), 221 p., $2.00 per copy, plus 12 cents postage.



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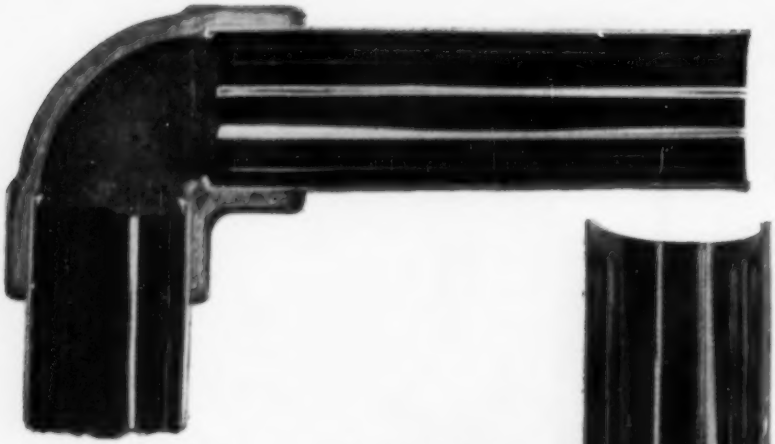
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## About our authors

**E. W. Burr,** manager of Personnel Development for Monsanto, tells of the long time interest in the processes by which change is effected in people, plus observations for the past seven years of the decision-making activities of middle levels of management, as background for the preparation of his article appearing in this issue of *CEP*. He feels that his comments (in the article) have value only as they serve to stimulate managers' awareness of the many facets of the problems of resistance to change. While he has made some effort in the article to relate his observations to current studies of leadership and group behavior, "this is not meant," he says, "to be a technical report or a psychological analysis of the problem."

**Howard A. Sommers,** who writes on his current survey of chlorine-caustic cells, is consulting engineer with Air Products, Inc., has been in engineering design or management of low temperature plants since 1923. About 1950 he joined Food Machinery as chief engineer, during which time he headed the engineering of soda ash plant at Green River, Wyoming, the carbon bisulfide and ammonia plants at Charleston, W. Va., and the dry ice plant at Lawrence, Kansas.

**Alfred M. Bretschger** is plant manager for Food Machinery's Becco Div. plant in Buffalo, N. Y. It was here that he, with co-author **Cootsona,** was associated with the first U. S. installation of mechanical rectifiers—at the same plant. After having observed the operation and maintenance of these units for the past eight years, Mr. Bretschger says, "with regard to the economic operation of our units on the West Coast, the single largest item for continued economic operation was the request for and approval of a voltage regulator with high per cent buck and boost which has aided immeasurably in the present continuous operation of our units and also in placing our units back on the line after a brief shutdown."

**Ivan Bloch** has been special consultant to a number of Secretaries of Interior on industrial development of the West and Alaska, as well as in charge

(*Continued on page* 36)



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# U.S.I. CHEMICAL NEWS

September ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1957

## *Protein Nutrient Balance Stressed in Newly Revised Study of Amino Acids*

The role of amino acids in maintaining protein quality in poultry and livestock is given special emphasis in the fourth edition of "Proteins and Amino Acids in Animal Nutrition", by Dr. H. J. Almquist, recently published by U.S. Industrial Chemicals Co.

Considerably revised and expanded, the 32-page reference work includes information on the latest research in the field of amino acids. Tables on the amino acid composition of common poultry feedstuffs have been enlarged, and several pages have been devoted to the effects on protein quality of heat treating soybean meal.

Copies of this useful reference work can be obtained from U.S.I. sales offices or by writing to the Editor, U.S.I. Chemical News.

## Field Ion Microscope Uses "Matter Waves" To Visualize Atoms

A new instrument called a field ion microscope substitutes the incredibly short waves associated with atomic nuclei for those of visible light to resolve the images of atoms in metals.

In principle the microscope is a very simple device, resembling a TV tube. It has a fluorescent screen and a fine tungsten needle corresponding to the electron gun that paints the picture on the TV screen.

A high voltage strips helium atoms of their electrons, and their nuclei then drift to the point of the needle. A powerful electric field applied between the tip of the needle and a second electrode in the tube hurls "matter waves" associated with the nuclei against the screen. Here the atomic pictures appear at a magnification of 10 million diameters.

The technique is presently limited to the study of hard, simple metals, but these may serve as models for the study of others.

# Molded Polyethylene Drums Pass Army Chemical Corps Rough-Handling Tests

### Polyethylene Containers in Steel Overpacks Promise Easier, Safer Handling and Storing of Corrosive and Sensitive Materials

A series of rough-handling evaluation tests of four types of overpacks carried out by the Army Chemical Corps indicates that containers of molded polyethylene in steel overpacks can reduce the costly breakage often experienced in shipping corrosive and sensitive materials.

Breakage sometimes exceeds 10% when material of this kind is shipped in boxed carboys and carboy bottles. This can be reduced considerably by polyethylene packaging according to a recent article in "Armed Forces Chemical Journal" by Kenneth D. Brunelli, Chemical Warfare Laboratories, Army Chemical Center, Md.

**Used 18 Drums In Various Sizes**

To make its evaluation the Army Chemical Corps used eighteen molded polyethylene drums in 55-, 30-, 15-, and 5-gallon sizes, encased in overpacks. These overpacks were open-flange steel drum, solid-head steel drum, open-flange plywood drum, and wirebound crate. Also included were two molded polyethylene drums without overpacks.

Tests were conducted according to the standard procedures of the Chemical Corps for material for this use, and consisted of (1) a two hour vibration test, performed on all plywood overpacks and half of the steel and wirebound overpacks; (2) a six foot free fall onto concrete; (3) an incline-impact test, performed on the overpack units only; and (4) a leakage test. All containers were filled with water to 98% of capacity.

**Polyethylene Units Showed High Degree of Burst Strength**

Polyethylene units without overpacks showed a high burst strength. They withstood the drop test, including a drop onto a 4 x 4 timber from a height of over six feet.

MORE

## *Defense Needs Help Define Role of Chemical Industry*

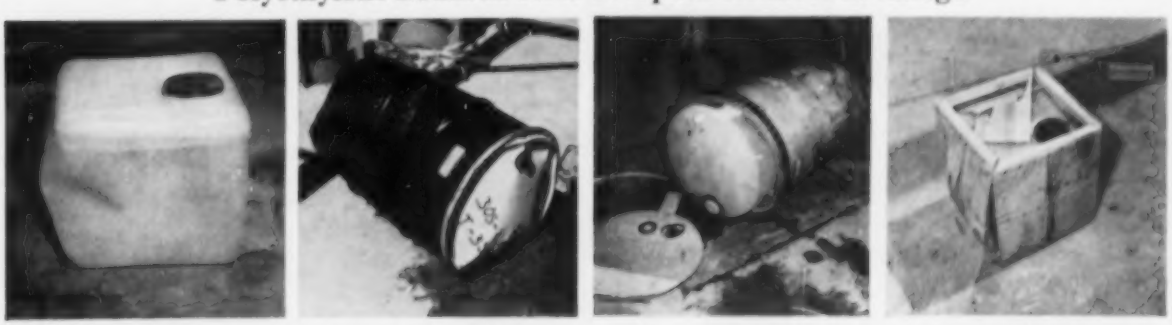
The chemical industry's awareness of defense needs is important to its own prosperity and the nation's survival, it was pointed out at a recent meeting of the Chemical Buyers Group of the National Association of Purchasing Agents.

This awareness is important to the industry, because new military uses for chemicals often point to profitable commercial applications.

It is important to national survival in case of attack, since much of the defense program depends upon continued production of chemicals for military equipment and civilian supplies. Awareness of recovery plans for industry will aid in a faster return to production and orderly flow of materials to defense programs, a government spokesman said.

The chemical industry is being encouraged to plan for continuity of management, to store plant designs, production techniques, research data, and other essential records, and to provide for plant disaster control.

## Polyethylene Drum in Steel Overpack Reduces Breakage



**These are representative views of combination containers following rugged tests by Army Chemical Corps. (A) Five-gallon molded polyethylene drum tested without overpack is still intact after drop. (B) Thirty-gallon polyethylene drum with open-flange steel overpack is still intact following a six-foot drop on a 4" x 4" timber. The leak that developed at plastic plug closure was readily stopped by tightening closure. (C) The drum of 55-gallon capacity with plywood overpack splintered following diagonal drop. (D) Drum in wirebound crate is still serviceable after three drop tests.**

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September ★ **U.S.I. CHEMICAL NEWS** ★ 1957

CONTINUED

## *Polyethylene Drums*

The polyethylene drums in combination with the steel overpacks gave the best protection to their contents, the report said. These overpacks were, however, deformed during the tests.

All of the plastic drums in the steel overpacks came through undamaged except for one 5-gallon size, which was punctured by the steel handle of its overpack.

The plywood and wirebound crate overpacks splintered under the rough usage, and the nails and staples of the plywood overpacks punctured the plastic.

Although leaks developed at the plastic plug closures following the drop tests, the leaks were stopped in every case by simply tightening the closure.

**Structural Failure Noted Only in One**

Of the twenty polyethylene drums tested, structural failure was noted in only one—a split along the top rim of a 30-gallon drum with plywood overpack.

As a result of these tests, it is reported that the Chemical Corps has recommended consideration of polyethylene drums in steel overpacks to replace glass or ceramic liners in rigid shipping containers for corrosive and sensitive materials that are compatible with polyethylene.

## *New U.S.I. Data Sheets On Organo-Aluminum Compounds Available*

Data on four new organo-aluminum compounds, now available from U.S.I. in pilot plant quantities, are contained in recently published technical data sheets. The properties of ethylaluminum and methylaluminum sesquichlorides, trimethyl and triethyl aluminum are described in four separate sheets.

The sesquichlorides are not true chemical compounds but mixtures of alkyl aluminum dichlorides and dialkyl aluminum chlorides.

Trimethyl and triethyl aluminum are being tested as ignitors and fuels for jet engines. The entire group also shows possibilities as polymerization catalysts and as intermediates for chemical synthesis.

## Titanium and Zirconium Studied for Surgical Uses



Titanium and zirconium have received more and more attention as materials for special surgical appliances, according to recent literature.*

Treatment of simple fractures is reputedly successful using titanium in a multiple plate technique without plaster immobilization. Tests on laboratory animals indicate that biological tolerance is high.

In one reported test, titanium discs were inserted into muscle, and the reaction compared with controls of tantalum, sterling silver and phosphobronze. After seven months the titanium was found to be inert and enclosed with a fibrous tissue capsule.

Lightweight, ductile zirconium has been tested for suturing, pegs, screws, and skull plates. Zirconium compares well with tantalum, it was said, causing no measurable reaction in muscle fascia, bone, or brain, and proved superior to silver. Hemostatic brain clips of zirconium can be flattened more uniformly and hold better than those made of tantalum.

In general, comparisons between tantalum and silver and stainless steel on the one hand, and titanium and zirconium on the other, reveal net advantages for the latter two in terms either of corrosion resistance, weight, elasticity, ductility, or cost.

*References
*Surgery*, 39: 470-3 (1956); *Surg. Gynecol. and Obst.*, 87, 212 (1948); *Jour. Neuro. Surgery*, 5: 359-361 (1948); *Jour. Neuro. Surgery*, 5: 342-348 (1948); *Surg. Gyn. & Obst.*, 71: 598 (1940); *J. Bone and Joint Surgery*, 33-A: 473 (1951).

## TECHNICAL DEVELOPMENTS

***Information about manufacturers of these items may be obtained by writing U. S. I.***

**An antiseptic coating material** can be applied to objects which are handled by the public but seldom washed. It is applied by dipping, spraying or brushing, is useful for many personal articles as well. **No. 1271**

**Continuous sodium dispersion technology** is described in a new USI brochure. Contains latest information on time-saving continuous preparation of dispersers. **No. 1272**

**A strippable coating** is available as a protection for metals and other surfaces against alkali and acid solutions, plating solutions, etc. Can be sprayed, brushed or rolled on. Thick coating is reusable. **No. 1273**

**Three controlled-viscosity release agents** for rubber and plastic molding and for die casting of certain alloys have been developed. They are said to be odorless, smokeless, non-corrosive, non-toxic. **No. 1274**

**An aerosol dispenser for gibberellin,** a new plant growth stimulant, has been developed. A glass vial with a metered valve provides measured dosages, is said to be both convenient and accurate. **No. 1275**

**New developments in laboratory equipment** now commercially available include corrosion testers, refrigerated centrifuges, stainless steel refrigerators, test cabinets, magnetic stirrers. **No. 1276**

**The technology of liquid metals** is discussed in a recent collection of papers now on sale in book form. The work deals with many aspects of the subject from the standpoint of the chemical engineer. **No. 1277**

**For joining, filling, cladding, and surfacing masonry materials,** three new plastic compounds are available. A brochure describes properties of the compounds and gives instructions for their use. **No. 1278**

**Simple castings for atomic shields** can be made from a new polyethylene-lead compound. The ratio of polyethylene to lead is variable for effective shielding against specific types of radiations. **No. 1279**

**The making of glass-reinforced epoxy impressions** is discussed in a new booklet. Applications of this widely used system are found in metalworking and model and pattern reproduction fields. **No. 1280**

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**PETROTHENE® 100 Series**—high quality resins for uses demanding outstanding properties.

**PETROTHENE 200 Series**—general purpose resins for extrusion, injection, compression molding and paper coating.

**PETROTHENE 300 Series**—resins for wire covering and electrical insulation applications.

### OTHER PRODUCTS:

**Alcohols:** Ethyl (pure and all denatured formulas), Normal Butyl, Amyl, Fusel Oil; Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL® PR.

**Inorganic Chemicals:** Ammonia, Caustic Soda, Chlorine, Metallic Sodium, Sodium Peroxide, Sulfuric Acid.

**Esters, Ethers and Ketones:** Normal Butyl Acetate, Diethyl Carbonate, Diethyl Oxalate, Ethyl Acetate, Ethyl Ether, Acetone.

**Intermediates and Fine Chemicals:** Acetoacetarylides, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate solution, Urethan USP (Ethyl Carbamate).

**Animal Feed Products:** Calcium Pantothenate, Choline Chloride Products, Curbay B-G® 80, Special Liquid Curbay®, DL-Methionine, Niacin USP, Riboflavin Concentrates, Vitamin $B_{12}$ and Antibiotic Feed Supplements, Vacatone® 40, Vitamin A, $D_3$ and $K_3$ Products, Antioxidant (BHT) Products.

**Pharmaceutical Products:** DL-Methionine, N-Acetyl-DL-Methionine, Riboflavin USP, Urethan USP, Intermediates.

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## Letters to the editor

### BRAINSTORMS: PUBLIC INTEREST AND PUBLIC DOMAIN

The letter of Stuart G. McGriff (*CEP*, June 1957, p. 14) raised an interesting question. Can a technical journal provide space for new and untested ideas relative to products and processes? I would like to flash both a green and a red light to the readers of *CEP* and to Mr. McGriff on the proposal.

Returning from a recent trip to Europe in which we visited many Roman ruins, the question often went through my mind, "What did the Romans lack which made their civilization almost disappear from the face of the earth and what do we have to do to make our civilization maintain itself in perpetuity?" This, of course, is a complex problem, but one phase of it is our industrial civilization which is of concern at this point. There is little doubt but that new products, new processes, and even new companies are the key to continuous growth and stability for our industrial life. The nature of our governmental complexities is such that the starting of new companies is becoming more difficult year by year. It is important that ideas concerning new and better ways to make products be given every opportunity to grow. The publishing of new concepts may bring them to the attention of people who might otherwise overlook them. Engineers as a professional group should be made aware of this need and the sponsoring of an outlet for people who have ideas could become a contribution in this regard.

The red light which I would like to flash is directed toward people who might write in their ideas for publication. The authors should realize that the only reward they can expect for their efforts is the public recognition they may receive for having proposed an idea and any satisfaction they may receive upon learning that it has been used effectively by someone else. Ideas are important, but they are only the initial step in a series required to bring forth a new product or process. A successful engineer and business man is one who can sort good ideas from the mediocre when making a decision as to which one to pursue. Any group of people who have been associated with an idea and its development to a successful fruition would look back and decide that the initial idea as presented was only a small portion of the total knowledge required in their overall venture. In addition to engineering and business acumen, one cannot neglect the capital investment required to develop an idea. The writer may resort to patent protection within a limited period of time after publication, but otherwise he has dedicated his proposition to the public interest when publishing it.

*Donald L. Katz*
*Ann Arbor, Michigan*

### Membership Drivers



McKetta Jones Tucker

Supplementing Membership Committee Chairman J. J. McKetta's communication of last month (p. 12), *CEP* readers are herewith introduced to the men behind the current Institute membership drive: Chairman McKetta (Univ. of Texas), Vice-Chairmen E. M. Jones (Monsanto) and W. H. Tucker (Purdue).—*Ed.*


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Posey has the experience as well as the facilities for fabricating almost any type of pipe from 20" diameter and larger . . . for high pressure, high temperature service in water lines, for sewage outfall lines and similar applications. Trust Posey to meet your most rigid specifications . . . with special attention to budget and delivery requirements. Write for complete information without obligation.

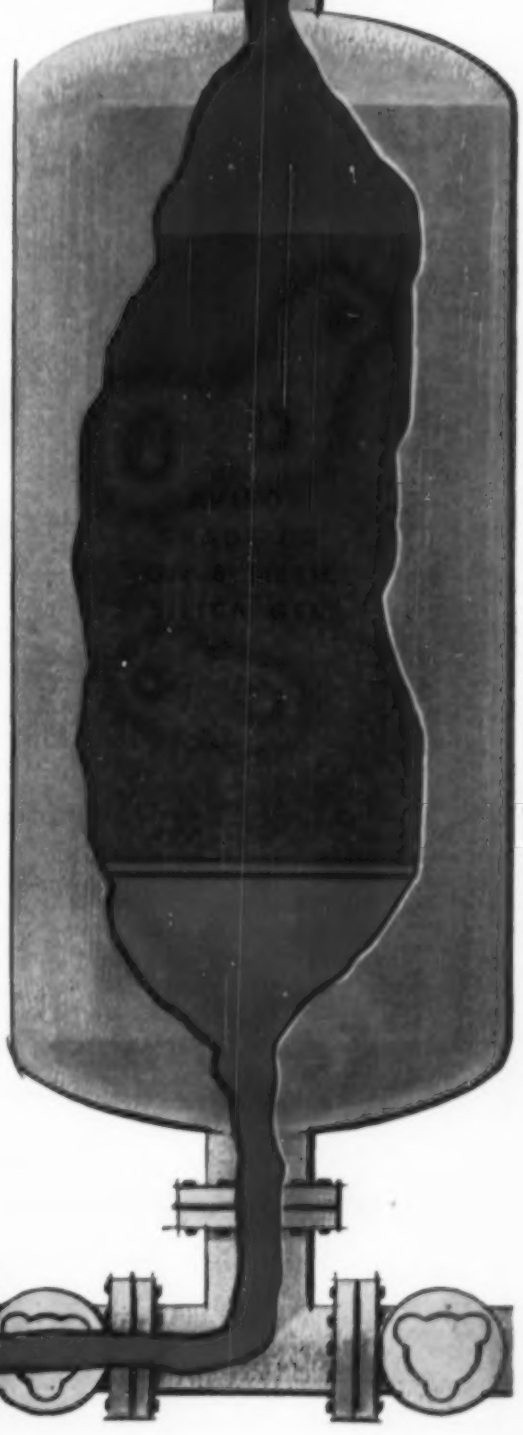
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Steel Plate Division Lancaster, Penna.
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**Uni-Construction**—Entire centrifugal—basket, curb, drive and accessories oscillate as a unit.

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Send me additional information on the Fletcher Tornado Centrifugal

NAME & TITLE

COMPANY

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## About our authors

*(Continued from page 28)*

of industrial and resources development for the Bonneville Power Administration—where co-author **Davidson** has specialized in statistical research and computer studies. Together, the authors have had numerous occasions to appraise the trends in the development of the electro-process industries in the U. S. The first series of studies began in the mid-1940's. Since then, principal studies were made in 1950 and 1954, both for the U. S. Corps of Engineers. These had to do specifically with prospects for the possible establishment and expansion of plant units in the Pacific Northwest.

The work on ethylene preparation using a molten lead bath was carried on at Monsanto's Texas City plant by **J. R. Fair** (now at Monsanto, Dayton) under the supervision of **J. W. Mayers**



Fair



Mayers



Lane



Soble



Dewey



Byrd

in 1944. The work was done in full-scale equipment which was one of a number of parallel units. At the time of the project, most ethylene manufacturers were having great difficulty in maintaining satisfactory operating factors and maintenance costs on tubular heaters for the high temperature service—a condition which was materially improved upon by the lead pot development. **W. H. Lane,** a co-author, started his career with a PhD and specialized training in pulp and paper technology. For several years he pursued this field until, with Monsanto, he broadened his field into styrene, vinyl chloride, and acetylene chemistry, chlorination and oxidative chlorination of hydrocarbons, and other areas.

**A. B. Soble,** who tells us of thermistors, has written 13 of a projected 20 papers and articles on various aspects of this interesting and promising new development. A staff member of Stevens Institute of Technology, he does electronic research there as

*(Continued on page 38)*



How Allis-Chalmers Can Help You

# Cut Heat Transfer Costs

Obtaining increased production, lower processing costs and improved product quality is more than a matter of installing the best heat transfer equipment. Maximum utilization of that equipment also calls for an *efficient flow design*. You get *both* from Allis-Chalmers.

**A-C Engineers Work With Your Staff or Consulting Engineers**

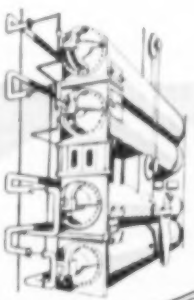
Allis-Chalmers engineers concern themselves with overall operation . . . the evaluation of variables . . . plant design . . . the integration of interdependent equipment into a complete process.

Pre-recommendation research, testing and, of course, expert installation and localized field service are also available from Allis-Chalmers — the world's leading manufacturer of rotary kilns, coolers and associated equipment.

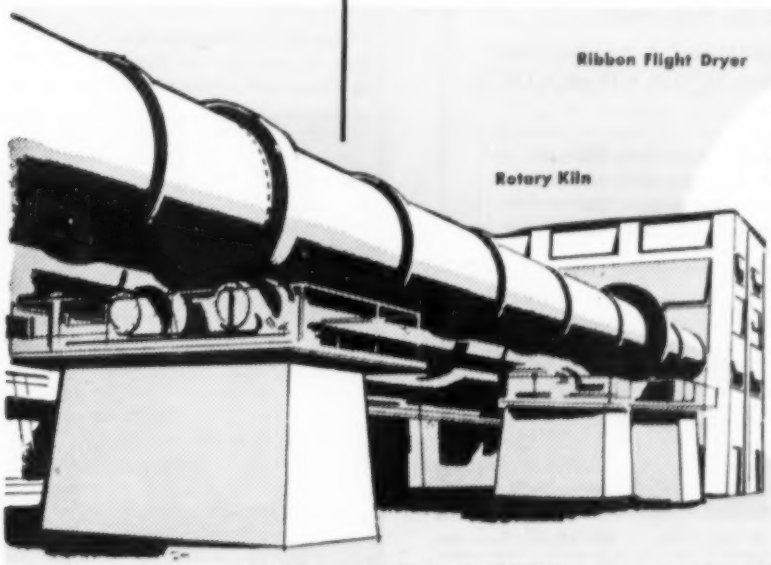
Equally important is the fact that Allis-Chalmers interest in your problems is continuous. Laboratory services, periodic equipment check-up and parts service are yours for the life of the equipment — and a long life it is, too.

**Partial List of Material Processed with Allis-Chalmers Heat Transfer Equipment**

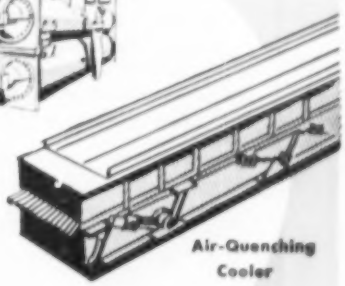
- Limestone
- Lime
- Dolomite
- Magnesia
- Alumina
- Bauxite
- Manganese Oxide
- Iron Ore
- Phosphates
- Refractories
- Foundry Sand
- Petroleum Sand
- Petroleum Coke
- Fuller's Earth
- Nickel Ores
- Copper



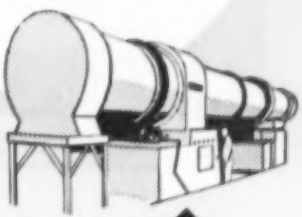
Ribbon Flight Dryer



Rotary Kiln



Air-Quenching Cooler

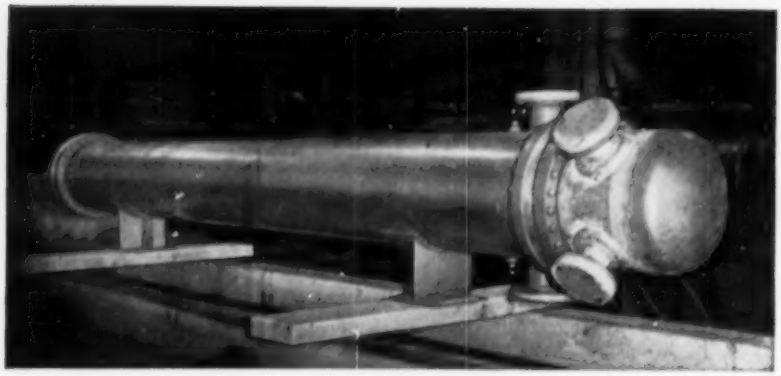


Rotary Dryer

**You'll want Bulletin 25C6177.** See your nearby A-C representative or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin.

**ALLIS-CHALMERS**

A-5325



# Aluminum translated by Downingtown ...metallurgically speaking

The special problems of aluminum welding and fabrication are another metallurgical "language" that has been expertly mastered at Downingtown. In this fixed-tube sheet heat exchanger unit, aluminum heads, tubes and tube sheets have been combined with a carbon steel shell to meet specific service conditions.

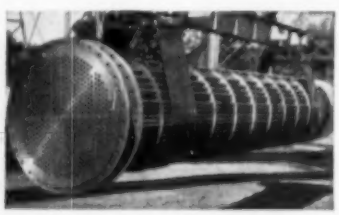
When heat transfer specifications call for aluminum...or aluminum bronze, nickel, copper, stainless steel, or almost any clad or alloy... you'll find the metallurgical idiosyncrasies are well understood at Downingtown. Send for our informative booklet on heat exchanger design.

**SPECIFICATIONS OF THE UNIT**

**Materials:** Aluminum Tube Side and Carbon Steel Shell
**Tubes:** 192 Alclad Tubes, ¾" O.D. x 16 ga. x 14'0" L
**Shell Diameter:** 18"
**Over-All Length:** 16' 1"
**Design Pressure:** Shell Side, 100 psi—Tube Side, 200 psi
**Test Pressure:** Shell Side, 150 psi—Tube Side, 300 psi
**Design Temperature:** Shell Side, 250° F.—Tube Side, 350° F.
**Code Stamped:** Inspected by Purchaser and Hartford



Putting the finishing touch on another heat exchanger unit built by Downingtown. We build to your specs, or do complete design.



We rolled type 329 stainless steel tubes into types 316 and 304 stainless tube sheets to make this stainless steel replacement bundle.

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Branch offices in principal cities
HEAT EXCHANGERS—STEEL AND ALLOY PLATE FABRICATION
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

## About our authors

(*Continued from page 36*)

well as in his own consulting laboratory.

**Ellis Dewey** is associate director of P & G's Engineering Division and is in charge of the Food Equipment Dept. **Floyd Byrd** is in charge of the pollution control section of that Dept. Both have been associated for several years in the process equipment design activities of the company. Dewey is said to be best known for his work in the development of "Osmo"—one of the first positive methods for measuring the amount of odor generated from a given source. Which sounds like a downright handy thing to have.

**Leo Friend** and **Stanley Adler** are both in M. W. Kellogg's design data section. They write: "We provide the company's process engineers with needed design information. In several instances complete design curves have to be constructed from a few experimental points. Such data are frequently changed over to a form so different that the original experimenter would not even recognize his own work. (Sounds like an editor's job description—*Ed.*) The article in this issue describes some of the difficulties we encounter and how we solve them."

**Joseph C. Schumacher,** vice-president of research for American Potash & Chemical Corporation, is one of the pioneers in the development and growth of the chlorate and perchlorate industry. He has been responsible for the design and construction of a number of large tonnage electrochemical and chemical plants including the large-scale production of ammonium perchlorate. He is now actively engaged in administration, development, and research in the fields of boron and lithium chemistry. **David R. Stern,** co-author and assistant manager of American Potash's Whittier Research Laboratory, served in the capacity of project supervisor on the ammonium perchlorate plant. Stern describes his experience since the perchlorate days as chiefly electrochemical engineering and electrochemical process development in the perchlorate, lithium, and boron fields.



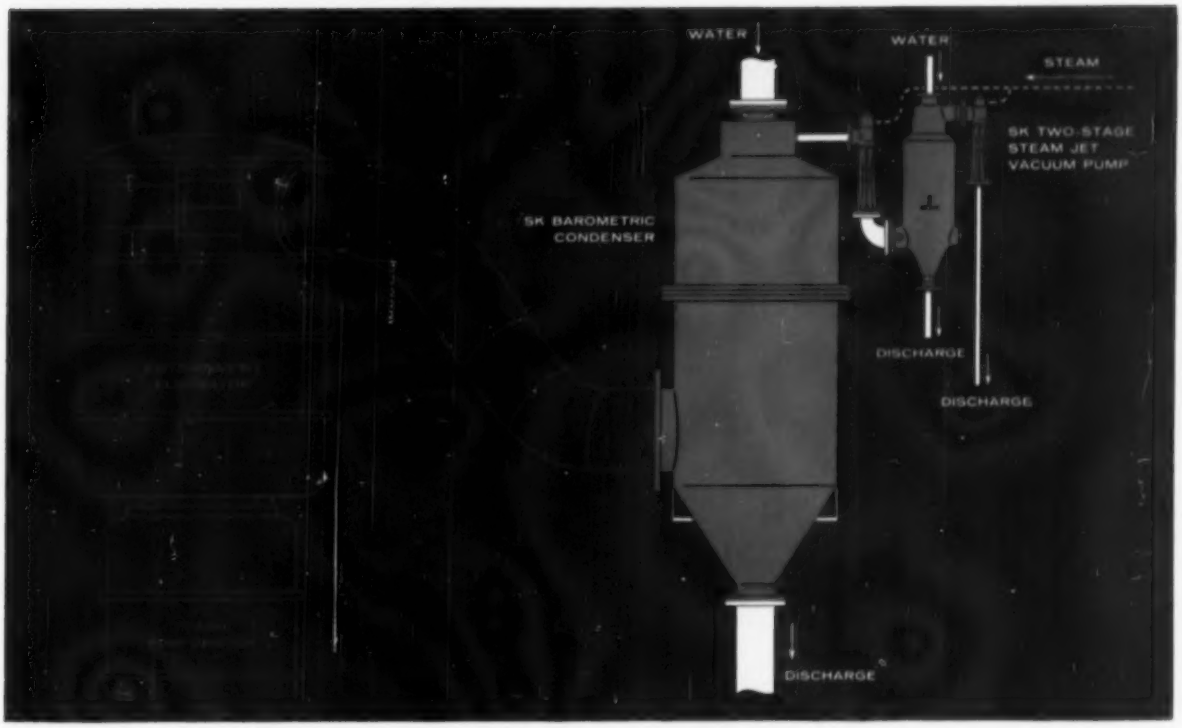
Friend



Adler



Stern




# SK VACUUM PUMP HELPS MANUFACTURER

## *make better product at lower cost*

SK Two-Stage Condensing Steam Jet Vacuum Pump



**SK Steam Jet Vacuum Pumps utilize the kinetic energy of pressure steam to entrain and remove gases and vapors. Because they offer outstanding advantages—simple design with no moving parts, low initial cost, and long life expectancy with little supervision or maintenance—they have opened a whole new field for application in the chemical and allied industries.**

**A typical example is shown above. This is part of a refined, improved process developed by a large southern manufacturer. The two-stage steam jet vacuum pump illustrated consists of two exhausters with a barometric counter-current intercondenser. It is used to maintain an absolute pressure of approximately 1 inch of mercury on a system consisting of a single effect evaporator together with an entrainment eliminator and an SK barometric counter-current pre-condenser. The condensable vapors are removed in the pre-condenser and the two-stage vacuum pump handles the non-condensable gases plus moisture of saturation. Two single-stage exhausters are used on a section of the process not shown to maintain vacuum on a dearator and a holding tank.**

**The improved process is outstanding in increased efficiency and control of product. And the SK Vacuum Pump has helped make it so.**

**Many sizes of Vacuum Pumps are carried in stock by SK and are available for immediate delivery. For material on Vacuum Pumps and for information on other types of SK Jet Apparatus, write for a copy of Bulletin J-1.**

JET APPARATUS. Ask for Condensed Bulletin J-1.
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HEAT TRANSFER APPARATUS. Ask for Condensed Bulletin HT-1.
GEAR PUMPS. Ask for Bulletin [illegible]

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Case No. 58

Results Bring Re-Order from Heyden Chemical Corp. for Second Kemp Inert Gas Generator

## Heyden Chemical doubles its blanketing savings with Second Kemp Generator

HERE'S A CASE where simple mathematics paid big dividends at this Garfield, New Jersey plant. When Heyden Chemical—one of the nation's leading producers of formaldehyde, pentaerythritol, salicylic acid, etc.—installed its first Kemp Inert Gas Generator to furnish $CO_2$ for blanketing a special grinding operation, it was on more or less a test basis. Part of Heyden's constant search for newer, better, cheaper ways to improve its products. The rest of its blanketing needs were still being handled with $CO_2$ from large storage tanks in the plant.

### Immediate Savings with Kemp

Results with the first Kemp Inert Producer were impressive. Now a second (see right) Kemp unit has been installed and actual savings over previous costs are estimated at over $500 a month for the first year. In addition to dollars saved, Kemp Generators assure a safe, dependable supply of chemically clean inerts. Deliver inerts at a special analysis . . . without fluctuations.

### Kemp Designs Versatile

If you still rely on old-fashioned inert sources or are dissatisfied with present inert equipment, let Kemp help you, too. Kemp Engineers will be most happy to help solve your inert problems . . . show you how you can get similar results with fast-starting, easy-to-operate Kemp Generators. It costs you nothing to investigate. And it may save you real money.

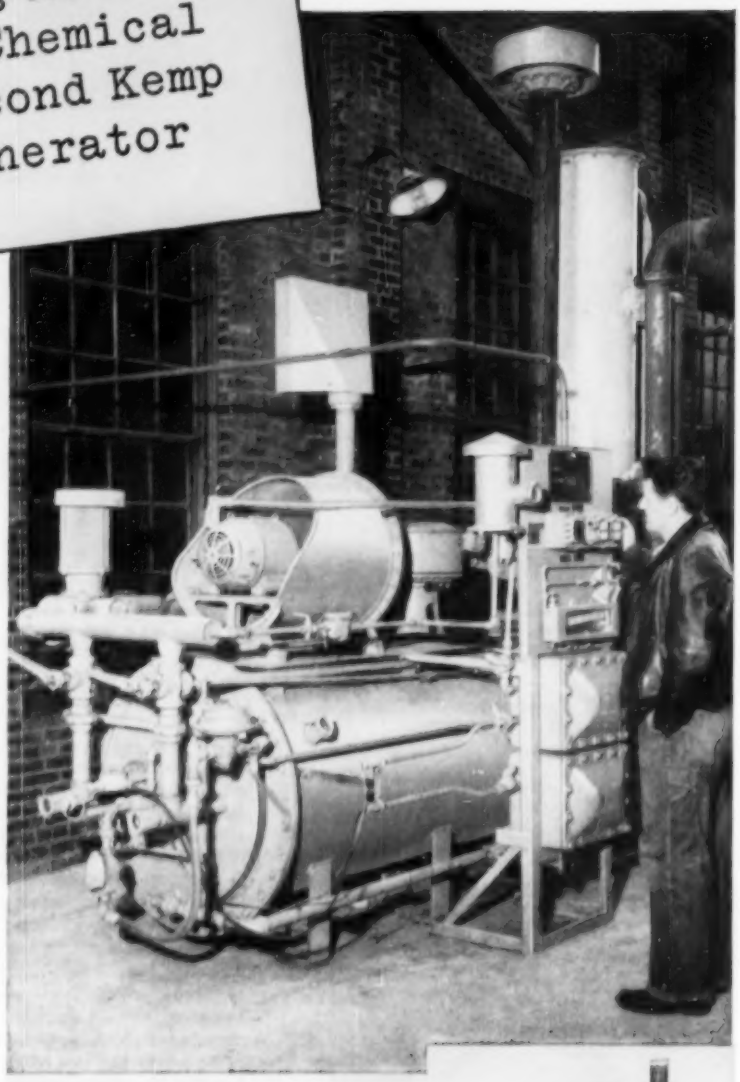
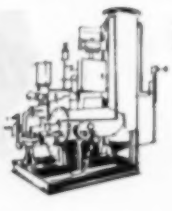




**Photo at right shows close-up view of Kemp Industrial Carburetor. Part of every Kemp installation, it eliminates tinkering, waste. Assures complete combustion at all times. Reduces installation costs and maintenance.**

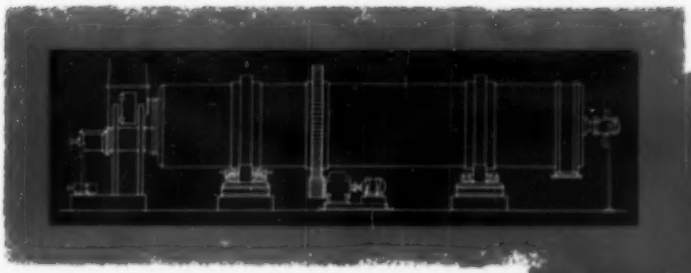
*For more complete facts and technical information, write for Bulletin I-10 to:*
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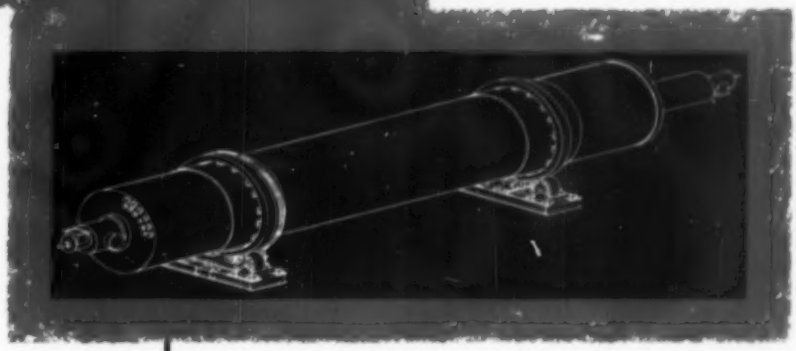


Continuous Atmospheric Rotary Dryer



Continuous Fluidized Bed Dryer

Continuous Solvent Stripper
Continuous Gas Solids Reactor
Continuous Vacuum Dryer



# Now, at one convenient location, you can test-dry your materials in a variety of equipment

At General American's East Chicago pilot plant, you can test the drying or reacting of your materials in the widest range of drying equipment ever assembled in one place.

Louisville Dryer engineers will work with you—study your materials and needs, make recommendations for type of equipment, size and heating medium. You can check these recommendations for yourself through practical tests. Your Louisville Dryer is then engineered for most efficient and economical service—built specifically to meet your needs.

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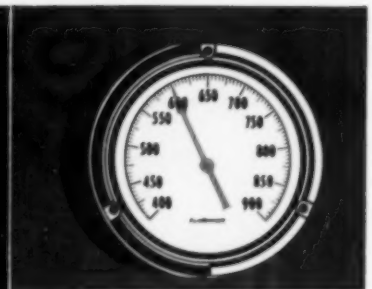
Continuous operating temperature up to 600° F.

# Isn't this the kind of heat transfer system you want?

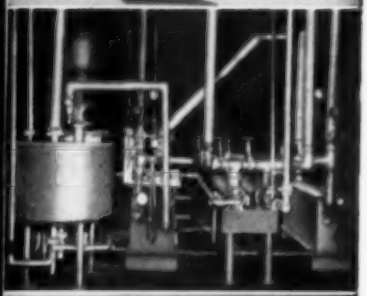
Pin-point control to within 2° F.

Lower cost, non-pressurized equipment

Safety from fire and explosion







**... THEN YOU WANT A**

## non-pressurized Aroclor 1248 system

Aroclor 1248 is a new kind of heat transfer fluid that's fire-resistant . . . operates at atmospheric pressure.

**The Equipment** . . . capacities can range from small portable units—usually electrically heated—to large gas- or oil-fired units generating from 250,000 to over 10,000,000 B.T.U.'s per hour. Circuits are closed, forced circulation. Compact design saves space, minimizes installation and maintenance costs.

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As the year turns toward autumn there have developed an increasing number of signs of uncertainty in the business picture and in finance. The stock market, often a business barometer, declined in the late summer and several pundits of the marketplace who have been bulling stocks for several years have now become openly dubious and even outspokenly bearish about the outlook for stock prices. They base this pessimism on what they see in the business picture.

In the forefront of the factors which have been important during the year has been first the talk of inflation and, lately, the open efforts by the Federal Reserve Bank and by the government to call a halt to the rising spiral if possible. Tightness in money has put business borrowing rates up from 4 to 4½%, sparked by an increase in the Federal Reserve rediscount rate to 3½%.

**Profit Squeeze**

Chairman Martin of the FRB, in talking to the House Banking Committee recently, said flatly that "we still have inflation and we have got to stop it"—leaving no doubt about the government's money policies. He went on to indicate that it would be unwise to make it easy for business to borrow money to carry inventories rather than move them out by price cutting. He went so far as to remark that "profits should be squeezed now when they can better adjust to it." Bolstering his point of view are indications that consumer spending is lagging in spite of the fact that wages and personal incomes are around record high levels.

During the summer, in spite of cautious buying policies in industry and efforts to reduce stocks of raw materials, inventories have continued to rise, leading to the inference that finished goods have been backing up in the hands of producers in spite of their best efforts to keep stocks low. Backlogs of orders in some fields have also been declining. Now industry as a whole is waiting hopefully for a Fall upturn, which may be disappointing, however, in view of the tightness of money and growing consumer resistance to high prices.

Although the tight money situation does not seem as yet to have affected big firms very much (particularly in their plant expansion programs), signs of difficulties are cropping up in small business. One drug manufacturer, for example, recently complained that he was getting an unusually high amount of returns from small merchants, even of products which had been showing a sales uptrend and therefore ought to move off the shelves easily. He accounted for this by the guess that a small merchant may have reached the end of his bank credits and may therefore have to raise what money he can, even at the expense of future sales. A continuation of this situation could of course subsequently affect the sales and profits of the bigger firms.

Certainly the chemical industry is as familiar as any segment of business with the cost-price squeeze that has affected their profits adversely during the year. In the first six months, earnings of chemical firms were on the whole down from a year ago. Little improvement can be looked for in the reports for the September quarter which includes the normally dull summer period and widespread plant vacations. This leaves only the final three months of the year to bring what improvement in the picture we are going to have. Chemical executives on the whole are fairly optimistic about business in the last part of the year and hope in some cases for better profit margins because of better prices in some fields, but the outlook is nevertheless somewhat cloudy.

**Placing the Blame**

As for inflation and its causes, opinions of course differ to some extent, depending upon which side of the political or business fence one sits. A great obvious and basic cost is government spending, especially for defense contracts. Efforts are now being made in Washington to cut this spending down, but how much will actually be accomplished is still not clear.

Another cause is the steadily rising scale of wages which in turn forces up prices. Here labor leaders such as Walter Reuther and business leaders naturally disagree—as evidenced by Mr. Reuther's suggestion that General Motors ought to cut the price of its cars. At the same time labor is beginning a drive for a 40-hour week, which could hardly be called deflationary.

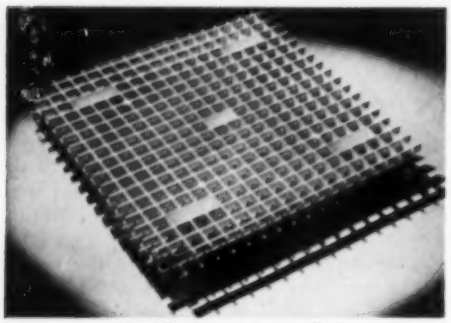
One strong statement on causes was made by Treasury Under Secretary Burgess before the Senate Finance Committee. He asserted that plant expansion at record levels was the direct cause of current inflation. He went on to point out that the inflation and boom in the 1920's was a commodity inflation; the 1929 era was a stock and security inflation; whereas today we have a capital goods inflation. There seems little doubt that this spending has been one factor.

Whether the heavy program of plant building in which the chemical industry has taken a leading role has been inflationary to the point where dangerous overproduction can occur for an extended period seems doubtful, although overproduction in some products for a temporary period has already occurred.

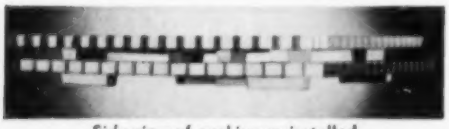
Certainly chemical managements which have been noted in the past for their prudence and long-range planning are increasing rather than cutting plant building programs for the coming year. It appears to be a race to get under the wire before costs go up even more.

# announcing

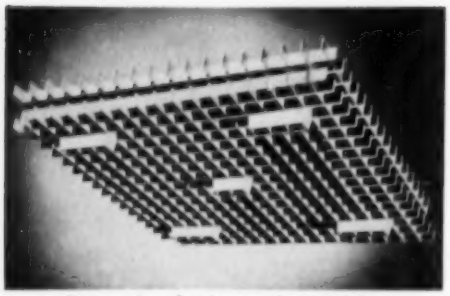
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Overall top view as installed



Side view of packing as installed



Bottom view showing spacing supports

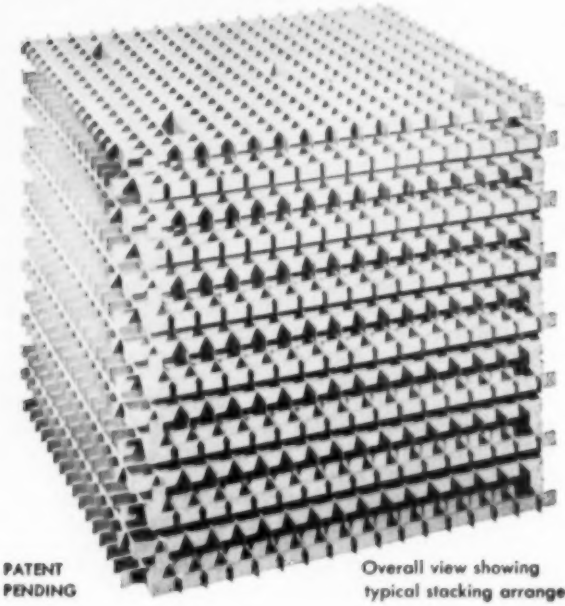
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## George Granger Brown

September 3, 1896—August 26, 1957

A DISTINGUISHED career ended last month when George Granger Brown left our physical world. His life encompassed many achievements. He was a notable educator and teacher, as many generations of chemical engineers from the University of Michigan will testify. His engineering deanship at Michigan, cut short by his death, was marked by outstanding accomplishments. He was a staunch champion of chemical engineering, and his terms as president of the American Institute of Chemical Engineers in 1944 and treasurer since 1953 and his long chairmanship of, among others, our Education and Accrediting Committee were characteristic manifestations of a lifelong devotion to his field. His research in chemical engineering was given freely to his associates in numerous publications and in the textbook *Unit Operations*, of which he was senior author. As the Edward DeMille Campbell Professor of Chemical Engineering, as the recipient of the Hanlon Award of the Natural Gasoline Association and of our own Walker Award, he was recognized by his fellow chemical engineers for his professional ability and distinction.

His career in industry too was outstanding, for in addition to maintaining a large consulting practice, he was Director of Research for the Natural Gasoline Association of America and National Dairy Products, he was Director of the Engineering Division of the Atomic Energy Commission, and he served as a director of the American Motors Corporation.

In Institute work it was his courage that brushed aside fears and launched our present publication program. Vivid memories are his leadership in encouraging the A.I.Ch.E. to begin a Nuclear Division and, despite an unfavorable budget, his foresight and judgment in urging Council to underwrite the Nuclear Congress held in Cleveland in 1955.

These all were the marks of a gifted man who used his gifts well and wisely for his generation, and yet they do not fully explain what made G. G. the great person he was. He knew how to be a friend, and those of us who knew him as such, how lucky we were! He was a marvelous person to have on your side in debate, and in opposition his pile-driving arguments soon reduced rock-bound positions to pebbles. He once said that the most important course he ever took was debating, and few who worked with him would disagree. His warm, personal interest was one of the rewards of working for the Institute.

His was a full life—active, bold, and intelligent. Chemical engineering has lost a leader; A.I.Ch.E. has lost a wise counselor; and chemical engineers have lost a friend—a rugged, courageous friend.

—F.J.V.A.

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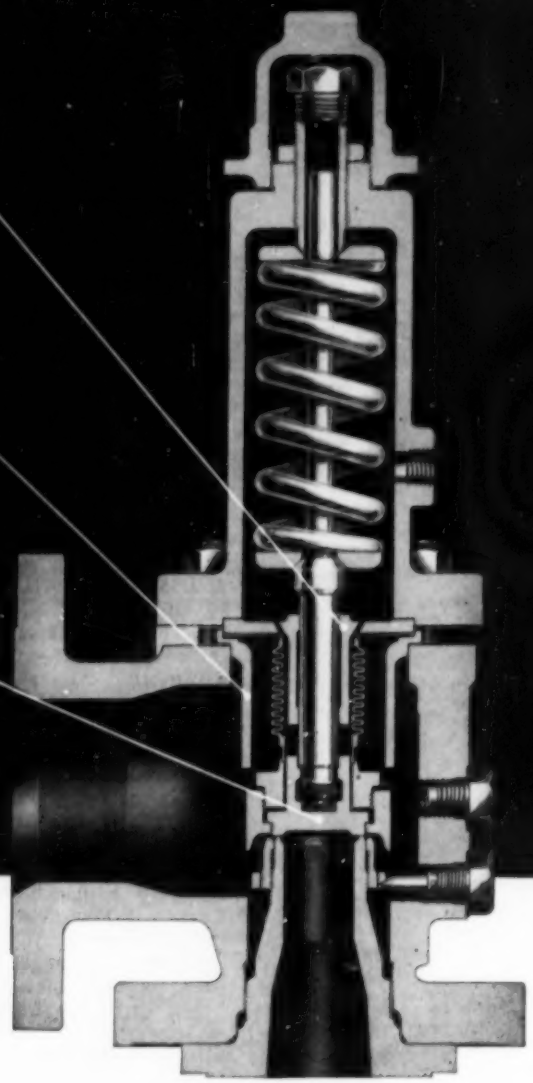
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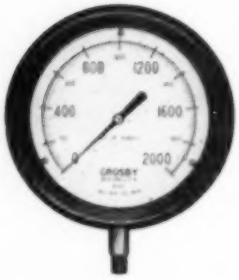
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In the October issue, *CEP* will publish an exhaustive tabular compilation (prepared by Mr. Sommers) which covers chlorine production in the United States and Europe as of June 1, 1957. These tables include a list of companies, plant locations, capacity, type, and characteristics of cells employed.



Outside view of Solvay four-level chlorine plant at Tavaux, France.

*H. A. Sommers*

Air Products, Inc.,
Allentown, Pennsylvania

# CHLORINE CAUSTIC CELL DEVELOPMENT

## IN EUROPE AND THE UNITED STATES

**Much has been written in recent years relative to the technology of chlorine-caustic manufacture, but the industry as a whole is changing so fast, particularly in Europe, that an up-to-date appraisal of the situation was felt to be of considerable interest to engineers here. This information was not obtainable in the United States, and the writer found it desirable to visit representative installations of de Nora, Solvay, Uhde, BASF-Krebs, and several others in England, Belgium, Holland, Germany, Switzerland, Italy, France, and in the United States. The impressions and conclusions gained from these visits will be discussed briefly in these pages in the hope that they will aid the industry in deciding on the best type of cells for future installations.**

The chlorine industry in the United States in 1957 will consume approximately 11 billion kw.-hr., or over 3% of its industrial electrical energy, and the alkali and chlorine will have a value of close to $500 million. At the present time the industry is growing at the rate of about 8 to 10% annually (*1*). Chlorine is without doubt one of this country's more important basic chemicals.

The trend in chlorine manufacture in the United States and Europe is more and more to the mercury cell, Europe having led the way tonnage-wise for the past twenty-five years. In 1942, 59% of the West Germany chlorine production was from amalgam—more popularly called mercury cells (*16*)—and in 1956 this rose to about 90%. For Europe as a whole, the figure is today about 85% (*14, 15*).

In 1946 in the United States, 88.6% of all chlorine produced was in diaphragm cells, and 4.3% in mercury cells (*14*); in 1956 the corresponding figures were 79.0% and 14.4%; in 1958 the percentages are expected to be 74.3% and 18.7% [Figure 1 and Table 1* (*18*)]. The reasons for the trend to mercury cells are quite complex, but in general it can be said that as plants get larger because of expanding economy, the smaller cells, with the multiplicity of parts, connections, etc., and higher capital and operating costs, simply cannot compete. Many of the older chlorine plants have cells in the 1,000 to 2,500 amp. class, whereas all new plants now being built have cells of the 30,000 to 180,000 amp. size.

* Tables 1 and 2 will appear in the October issue.

A complete list of all chlorine plants in the United States is shown in Table 1 with projected expansions in 1957 and 1958, and a similar list for Europe in Table 2.* It can therefore be seen that the trend, both here and abroad, is definitely *to the smallest number of the largest cells*, and the Solvay plant at Tavaux, France, of 250 tons/day (metric) is a good example of this. This plant uses only 48 180,000 amp. cells built on four levels of twelve cells each. This is without doubt the most original chlorine plant the writer has yet seen. It is manned by only three operators per shift, and includes rectification, cell room, salt handling, and purification. A similar 4-level plant is now in operation at Linne Herten, Holland, and a 2-level plant at Rossignano, Italy. Although the use of minimum ground area is certainly an important consideration in these designs, as with all cell suppliers, the other important objectives are (1) to produce a high yield per unit of over-all plant investment; (2) to minimize maintenance and repairs; and (3) to minimize operating labor.

For a new installation, the average capital cost of a large diaphragm cell plant (100 tons/day or larger) with the largest Hooker cells available, will be about the same as one with the larger mercury cells—approximately $90,000 to 100,000 per daily ton, such cost depending on local conditions (*16*). This includes the cell plant with

A.C.E.P. SPECIAL FEATURE

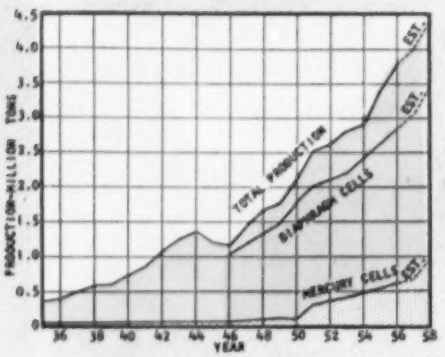
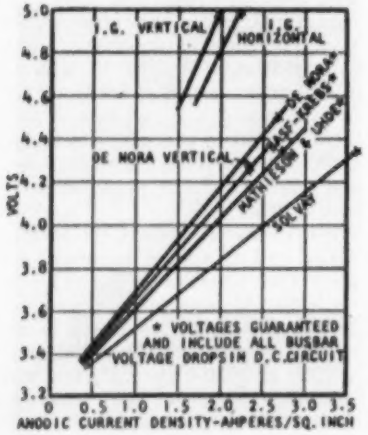



Fig. 1. Production of chlorine—1935-1958.

buildings, brine purification, power transformers, and rectifiers. Space here does not permit a complete analysis of the best cell choice for all conditions. Such factors as relative cost of power and fuel, plant size, cost and purity of salt, and its availability as brine or solid must be considered. If other products such as KOH, metallic sodium, or end products using sodium (or potassium) amalgam are required, these will also influence the type of cell to be chosen.

It can however be stated that *in general*, the capital and operating costs of the newer mercury cell plants will be somewhat lower than comparable diaphragm plants. Where the purest caustic is required, it is generally conceded that the mercury cell is more desirable because of the ease with which 50 to 73% caustic can be made directly in the cell and further, purified diaphragm cell caustic cannot quite meet the quality of the mercury cell grade. The trend to more mercury cell plants is a direct result of these basic facts and many chlorine experts have long wondered why the industry in the United States has been slow to appreciate them.

Fig. 2. Volt-ampere characteristics of various mercury cells.




The more important details of five horizontal and one vertical mercury cell are tabulated in Table 3 (p. 416)—the Mathieson, Uhde, BASF-Krebs, de Nora, and North American Solvay—and a study of these data is necessary in order to determine a preference. Large installations of all these cells will have been completed on the North American continent by the end of 1957. Data on the Hooker diaphragm cells are shown for comparison purposes. (See also Figure 2.)

Many articles describing mercury cells have been published (*2, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 17*), and it may be in order to touch briefly on the basic underlying principles.

Mercury cells may be classified as follows:

(1) *Electrolyzers*
- (a) horizontal flowing mercury cathode
- (b) rotating vertical steel cathode
- (c) vertical falling film cathode

(2) *Decomposers*
- (a) horizontal flowing
- (b) vertical graphite packed towers, nonflooding respecting mercury
- (c) vertical graphite packed towers, flooded respecting mercury

All horizontal cells operate in much the same way and differ only in the size, design, and arrangement of the component parts (see Figure 3). A mercury cell electrolyzes purified sodium (or potassium brine) at close to saturation, at a temperature of up to 90° C., to form amalgam and chlorine gas. This takes place on a gently sloping bare steel, stone, or rubber-covered surface, with adjustable graphite anodes disposed about 2 mm. above a thin sheet of mercury flowing slowly from the upper to the lower end of the cell by gravity. The amalgam continues on through a second compartment called the decomposer (or denuder) where the sodium (or potassium) of the amalgam is reacted with purified water to form caustic soda (or caustic potash) and hydrogen, and by varying the amount of water fed to the cell, pure caustic soda up to 73% can be produced. The mercury is pumped then to the upper end of the electrolyzer for another trip through the cell.

The amalgam on the cell bottom is cathodic, and the graphite anodic. About 15% of the salt content of the brine is electrolyzed on each trip through the cell, and it, of course, must be resaturated before return to the cell for further decomposition.

Nearly pure chlorine and hydrogen gas are vented from the electrolyzer and decomposer compartments respectively.

The decomposer may be a vertical graphite-packed tower, or horizontal, circular or rectangular in section, tilted slightly like the electrolyzer, with graphite-slat-type grids resting on the bottom. In either type, the flow of water and amalgam is countercurrent for 50% caustic, but is usually cocurrent for 70%. The electrochemical reaction takes place and hydrogen is discharged out the top and mercury and caustic as indicated.

### Details of Five Horizontal Cells

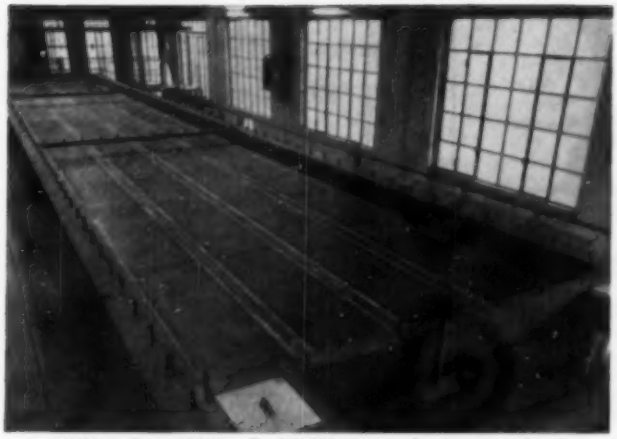
#### MATHIESON E-8 CELL

• Until October, 1955, this was the only domestic mercury cell available for license in the United States. It has been well publicized (*14, 19*), hence only passing reference will be made to it here. It is a well-designed, small cell of only 30,000 amp. capacity, with a bare steel electrolyzer bottom, a two-stem adjustable anode with a porcelain sleeve and rubber diaphragm, vertical decomposer, and short-circuiting switches for every two cells. Due to its small size, about 100 of these cells are required for a 100 ton/day plant, which puts them at a serious disadvantage as regards the size of the building required (see Table 3) and in maintenance and operating attendance. The mercury inventory is the highest of all the cells described (322,000 lb. for a 100 ton/day plant) due entirely to the small cell size.

#### UHDE CELL

• This cell represents the slow and perhaps nearly ultimate perfection of the horizontal German mercury cell during the past twenty-five years by I. G. Farbenindustrie and others (*10*) (see Figure 4). It features a bare steel bottom and rubber-covered steel sides and top, adjustable anodes, eight gang switch—all much the same as Mathieson, but in 50,000 and 100,000 amp. sizes. The cell bottoms, covers, and sides are sectionalized. Such cells have some advantage, as the two ends do not need to be replaced at the same rate—the rubber covering of the lower (hotter) half has a somewhat shorter life. The rigid cover—in four sections—is held in place with C-clamps. The older cells used a multiplicity of bolts and nuts, which were time consuming when the cell had to be opened for cleaning and replacement of anodes.

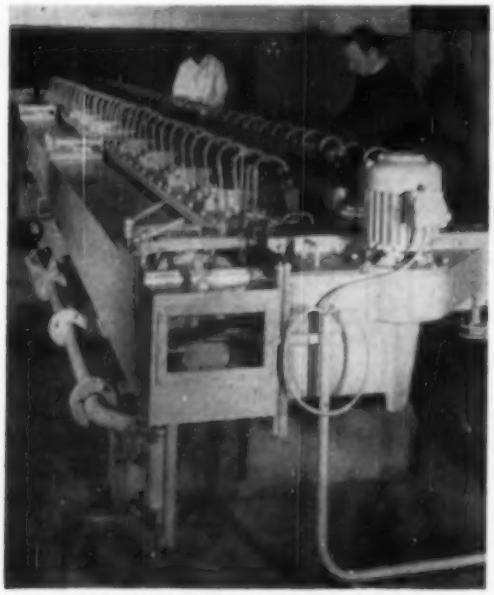
The horizontal decomposer is arranged at the side of the cell, or under it. Uhde builds cells either way, but appears to favor the former arrangement due to its somewhat better accessibility. In the interests of reducing the size of the building, with properly



DeNora Type 18SGL cell—120,000 amps.—showing stone lining and longitudinal cathode bars.



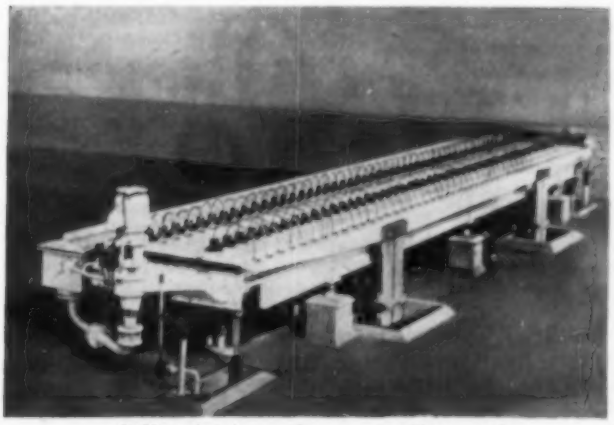
BASF, Ludwigshaven, Germany, 120,000 amp. cells under construction.



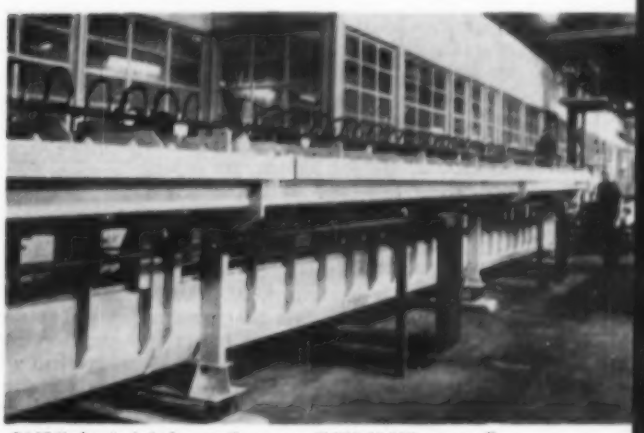
Uhde 40,000 amp. prototype cell, Hoechst, Frankfort, Germany.



BASF-Krebs cells at Ludwigshaven, Germany. 120,000 amp. cell at right, 40,000 amp. cells in background.



BASF, Ludwigshaven, Germany, 40,000-amp. cell.



BASF-Krebs, Ludwigshaven, Germany, 60,000-80,000 amp. cell.

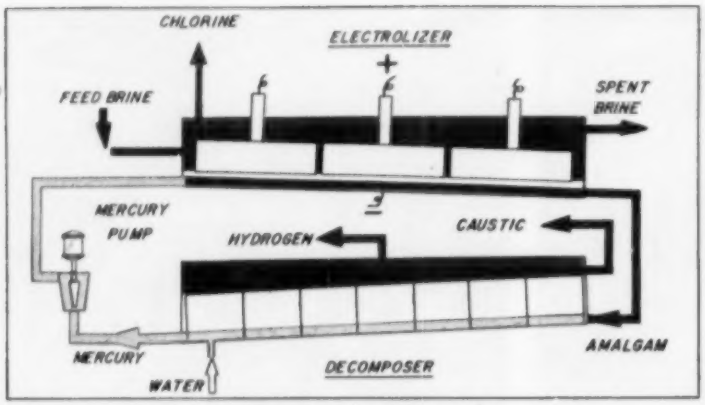



Fig. 3. Diagram of a mercury cell with horizontal decomposer.

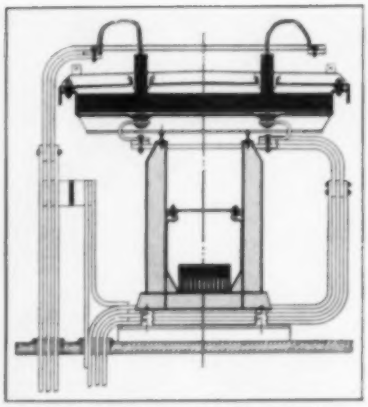


Fig. 5. BASF-Krebs 90,000-amp. cell.

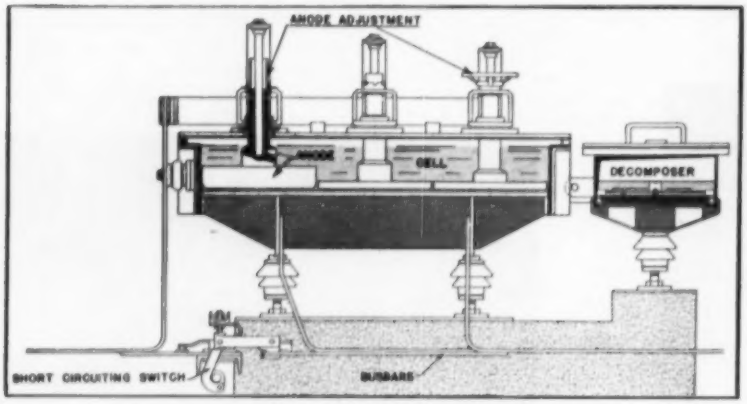



Fig. 4. Uhde 80,000-amp. cell.

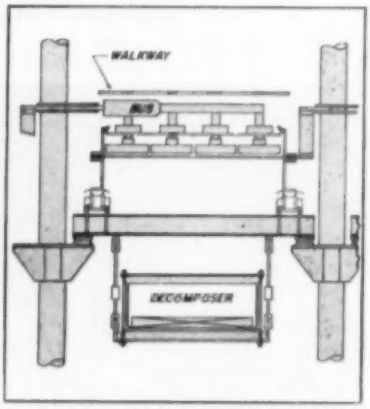



Fig. 8. Solvay 170,000-amp. cells installed on two or four levels.

purified brine, it is felt that the under cell arrangement is entirely practicable.

Uhde features quick-acting, spring-powered switches, actuated by a float in the mercury sump to short-circuit the cell automatically if an interruption in mercury flow across the cell bottom should occur. Dangerous quantities of hydrogen will be produced in all steel-bottomed cells in a short time unless they are quickly short-circuited. Whereas this is theoretically a desirable device, the writer believes that the conventional signal light and horn, warning the operator of trouble, is sufficient for all practical purposes. Manual operation (where switches are provided) is the rule for the other cells described here. The Uhde cell uses 224,000 lb. Hg for 100-ton/day capacity, about the same as BASF-Krebs and the de Nora horizontal cell.

#### BASF-KREBS CELL

• This cell is built in 40,000, 80,000 and 120,000 amp. sizes the same as Uhde and differs from all others in having a one-piece, completely rubber-covered bottom and sides in both the cell and decomposer (see Figure 5). The cathode connections are large, flat-headed bolts with the heads slightly lower than the cell bottom so as to be covered always with mercury in the event of pump failure. The cell bottom is semirigid and the slope is adjusted to a uniform degree by a multiplicity of leveling screws. The slope is only 2 to 3 mm./m. less than all other cells—probably amalgam flows more easily over rubber than the ordinary "wetted" steel cell bottom. BASF-Krebs claim that the additional cost of the rubber covering more than pays its way through the safety factor of no hydrogen evolution in the event of emergency shutdowns through power failure. In areas where frequent power failures are the rule, this might be justifiable, although with proper operation the bare steel bottoms of the Mathieson, Uhde, and Solvay cells certainly give a good account of themselves. It is probable that the life of the rubber lining on the cell bottom is somewhat shorter than the conventional average six years expected from the sides and tops. BASF and Krebs have had a long experience with both horizontal and vertical mercury cells and they are firmly sold on the rubber-covered cell bottom.

#### DE NORA CELL

• The de Nora cell is built in sizes up to 120,000 amp. and, since there are at least five installations in the United States, and considerable publicity (*2, 4, 5*), it is probably better known here than the other cells discussed (see Figures 6 and 7). It is a well-designed cell with a special stone lining in bottom and sides with longitudinal steel cathode bars in the bottom, slightly depressed below the stone level. The stone lining is reported to have a life of about six years, equal to the best rubber covering. In earlier installations (Muscle Shoals) there were reports of trouble with the lining floating loose but in the newer installations this has been successfully solved. There is an added advantage that repairs can be made in place if necessary.

The de Nora cell uses a vertical decomposer which the writer feels is not as desirable from all standpoints as the horizontal. Because of the slight degradation of the graphite packing in vertical decomposers, the resulting caustic must be filtered. This is, however, easy to do but is not necessary with the horizontal denuder. de Nora,

in the newer cells, uses adjustable anodes—all the others do now (absolutely mandatory for minimum power consumption)—and has a unique arrangement permitting individual anode adjustment, or in groups of 12 or more, by a simple screw arrangement. The entire assembly of anodes is supported on a steel framework resting on adjusting screws at the cell sides and the whole top of the cell is a ¼ in. flexible rubber "diaphragm" through which the anodes pass. This top is reported to have a life of at least one year. Since the anodes at the hot, discharge end of any cell wear away relatively faster than those at the other end, in order to equalize this it is possible to rotate the whole anode assembly end for end. In general, this is also possible with the other cells described, although Solvay uses a different technique.

The de Nora cell is reputed to be a rugged cell and to give a good account of itself particularly with not-too-well trained operators and in locations where power outages are frequent (*12*).

### SOLVAY CELL

• This cell, as previously mentioned, is built in the largest size of any (up to 180,000 amp.) and it appears that its technical development has progressed further in a number of ways



than have the others (see Figure 8). Although not necessarily designed to save ground space, the Solvay cell, as previously mentioned, is currently in operation at two locations with a four-level arrangement (Tavaux, France, and Linne-Herten, Holland) and at Rossignano, Italy, with a two-level design. As can be seen from Table 3, since the cells are located side by side without aisles and the operators

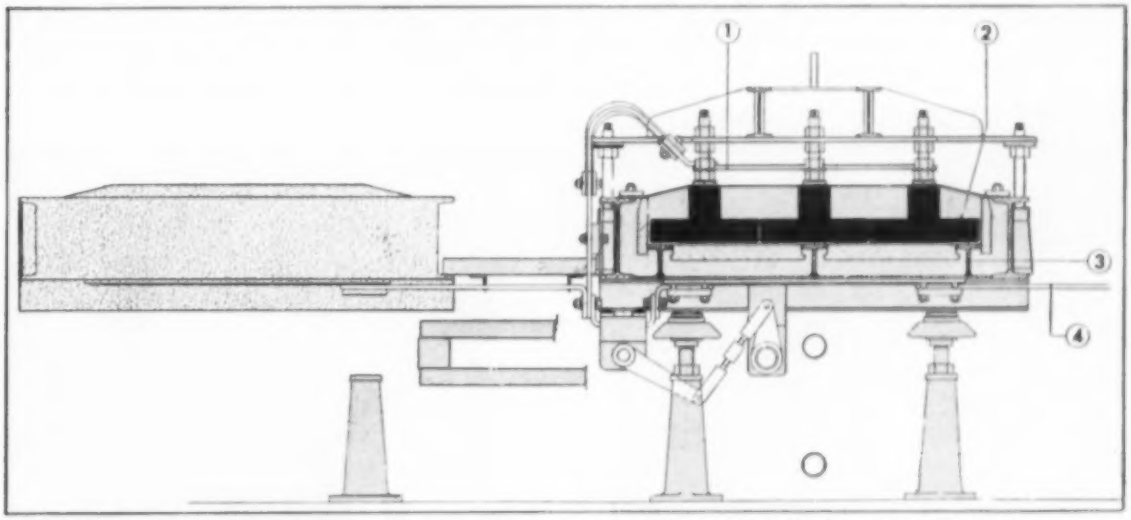



Fig. 6. Cross section of de Nora 40,000-amp. mercury cell Model 14TGL. 1) Anode bus bar. 2) Graphite anodes. 3) Steel cathodes. 4) Bus bar.

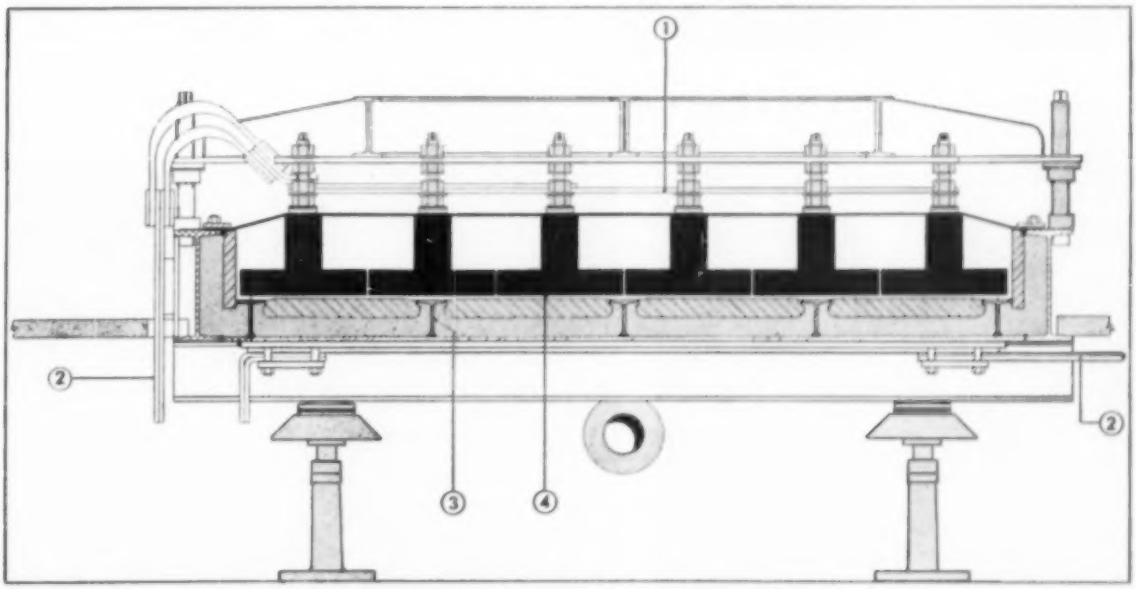



Fig. 7. Cross section of de Nora 120,000-amp. mercury cell Model 18SGL. 1) Anode bus bar. 2) Bus bar. 3) Steel cathodes. 4) Graphite anodes.

walk on *top* of the cells, the floor space per daily ton of capacity is much less than for all other cells except the Hooker S-3B and the de Nora vertical cell. This is for one-level arrangement and, if two or four levels are used, the Solvay figure is reduced to one half or one fourth as the case may be.

Advantages of the Solvay cell may be summarized as follows: They use graphite anode "diaphragms" instead of relatively short-lived rubber, and as can be noted in Figure 8, the anode stem has a tight slip fit in a graphite sleeve which accurately keeps the anode level; and flexible copper lead-ins, cable or bus-bar, are not needed as the current is fed in through the tight fit of the anode sleeve and stem.

Cell covers are in multiple sections, on wheels, instead of heavy one-to-four-piece designs which must be lifted off from above. As the covers are handled only at the cell ends, the conventional lifting crane straddling the entire cell area is not required—only a ½-ton hoist and monorail at the ends. A simpler building construction with inside columns is possible. Cell covers are sealed by means of 1-in. diam. inflatable rubber tubes (see Figure 9) instead of a multiplicity of bolted flanges or C-clamps—a neat and labor saving arrangement.

The mercury pumps take minimum power and can be changed in a few minutes without stopping the cell. No aisles between cells are required, a condition which results in minimum floor space per ton as previously mentioned and, if space is at a premium, a two or four-level design is available.

A weak chlorine header permits cells to be instantly vented in emergencies and the cost of short-circuiting switches is saved. Fewer spare cells are required, but the cost of a stand-by caustic scrubber for the vented (and weak) chlorine tends to offset this. Cells can be cleaned, anodes changed, etc., under full load.

A labor and power saving robot anode adjuster is currently under test (see Figure 10). The probability is that this will prove to be worth-while.

The Solvay decomposer graphite grids can be oscillated back and forth by operating a hand lever which flushes away solid accumulations without manually touching the grids.

Of great importance, when one considers the high cost of mercury, is the requirement of the V-200 cell of less than two thirds as much per daily ton of capacity as any other horizontal cell. Complete instrumentation and centralization of controls permits minimum labor attendance—only three operators per shift at Tavaux for 250 tons/day.

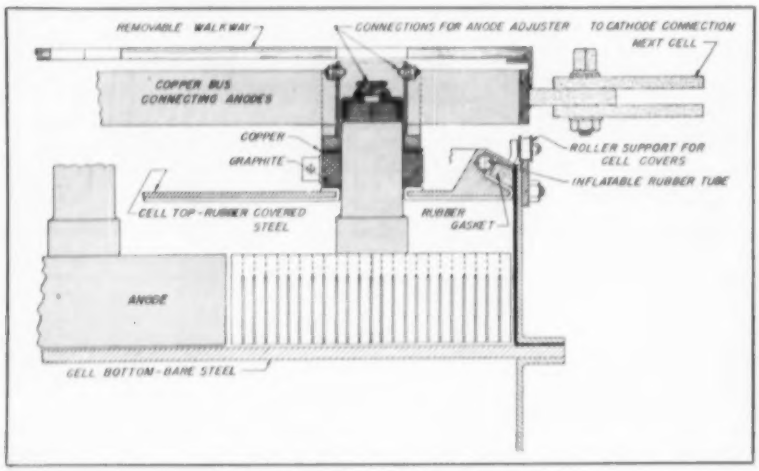



Fig. 9. Solvay cell—adjustable anode details.

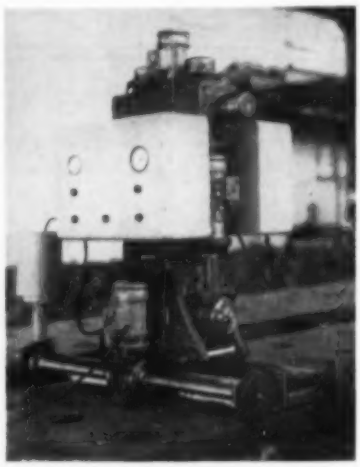


Fig. 10. Solvay automatic anode adjuster.

### Details of One Vertical Mercury Cell

#### DE NORA FLUENT AMALGAM CELL—FAC-16

• The vertical cell per se is not new and has been well described in the literature (*16, 17, 21*).

The rotating cathode installation at BASF, Ludwigshaven, Germany, has been in operation for at least twenty years but still suffers from high operating costs principally because of the nonadjustable anodes. Their current expansion is by way of 80,000-amp. horizontal cells previously described which tells their economic story—they simply cannot compete.

De Nora, probably recognizing that horizontal cell development has progressed about as far as it can go, has been experimenting with a vertical cell of his own design for the past six years. This cell is pictured in Figure 11 and represents a new approach to the problem. The 40,000-amp. cell consists of 17 anodes, 50 mm. thick and about 1 m. square, mounted some 12 mm. apart in a rubber-lined steel tank with bare steel bottom. Between each pair of anodes an 8-mesh steel cathode screen is exactly located, held plane in a steel frame on sides and bottom. At the top end it passes through a machined slot in a 1 in. steel pipe and is welded into the pipe at the top as shown.

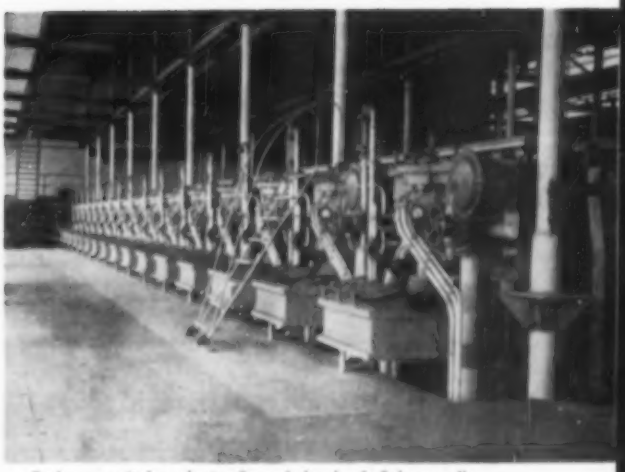
Through this pipe is fed mercury containing about 0.06% sodium which wets the screen and it trickles down in a remarkably smooth, even film about 1 mm. thick. The amalgam flows out the bottom through a seal to the sump under the decomposer. It is picked up by the pump and part delivered to the top of the decomposer and part back to the cell. This is a deviation from normal practice as it is necessary to have amalgam flowing down the cathode—to "wet" it—rather than mercury.

Each anode consists of three pieces of graphite sealed in a rubber-covered-steel channel with pitch at the top and in a bare steel channel in the bottom. The three copper anode lead-ins pass through the anodes vertically and are also sealed in lead at the bottom. They are protected by means of a plastic shield as shown.

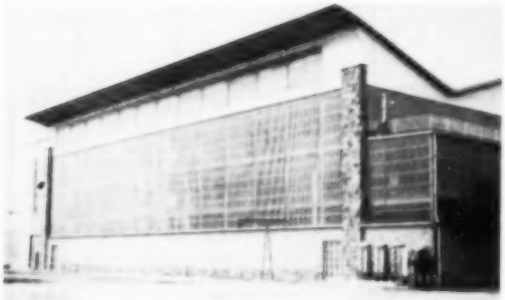
Each anode is vertically grooved and enclosed in a plastic fabric diaphragm. It is required as a bubble screen to avoid excessive turbulence at the cathode and to prevent hydrogen from getting into the chlorine. At a current density of 2,500 amp./sq. m., the diaphragm accounts for a voltage drop of about 0.07 v. The current efficiency is a little higher than for the horizontal cell—97%. Without the dia-



De Nora Type 14TGL cells, 40,000 amps., Weyerhauser Timber Co.



Rosignano, Italy, plant. Second level of Solvay cells, showing the inlet end of the decomposers under the cells.



Outside view of Solvay two-level chlorine plant, Rosignano, Italy.



Four-level Solvay chlorine plant, Tavaux, France, showing manual adjustment of anodes.



Solvay chlorine plant, Tavaux, France, showing first level of cells.



Uhde twenty square meter cell at Leverkusen, Germany.

phragm, it is reported to be about 80%.

No way has yet been found to adjust anode-cathode spacing due to wear and it is probable that this is inherent in the vertical cell. This imposes a serious voltage penalty, and de Nora gets around this by operating at the low current density of 2,500 amp./sq. m. de Nora maintains that since the cathode is active on *both* faces, and since the vertical cell only costs about two thirds as much as the horizontal (less copper, mercury, graphite), a lower current density can be justified.

The prototype cell has been in operation for over a year and it is claimed that the voltage starts in with new anodes at about 4.0 v. and increases to 4.6, the average being about the same as for the horizontal cell with weekly anode adjustment.

With reference to Table 3, it can be seen that the floor-space requirement is only a little more than for the Hooker S-3B and the Solvay V-200. The mercury requirement is likewise lower than for all others except the Solvay cells.

The vertical cell can easily be built in almost any size by simply making it longer—using more and/or larger anodes—and it is a certainty that the factors of space, mercury requirement, and cost will be materially improved.

**Table 3—Characteristics of Various Diaphragm and Mercury Cells Available for License in United States**

Base—100 short tons per day chlorine capacity

| | Manufacturer | Hooker diaph. | Mathieson[1] | | Solvay | Uhde | | BASF-Krebs | | De Nora horizontal | | De Nora vertical |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Type of Cell | S | S-3B | E-4 | E-8 | V-100 | V-200 | 10 sq.m. | 20 sq.m. | T-ATGL | 18SGL | TAC-16 |
| Number of cells installed | | 304 | 114 | 204 | 104 | 33 | 19 | 78 | 60 | 78 | 26 | 78 |
| Number of cells in operation | | 300 | 112 | 200 | 100 | 32 | 18 | 76 | 38 | 76 | 25 | 76 |
| Rated amps. | | 10,000 | 27,000 | 15,000 | 30,000 | 96,000 | 170,000 | 40,000 | 80,000 | 40,000 | 120,000 | 40,000 |
| Maximum amps. | | 13,000 | 30,000 | 20,000 | 34,000 | 110,000 | 190,000 | 50,000 | 100,000 | 50,000 | 150,000 | 50,000 |
| Anodic area—sq.m. | | 10.2 | 20.4 | 4.0 | 8.0 | 17.31 | 28.86 | 9.7 | 19.3 | 11.1 | 21.8 | 11.34 | 29.1 | 21.0 |
| Anodic current den. at rating—amps. sq.m. | | 980 | 1,330 | 3,750 | 3,000 | 5,550 | 5,890 | 4,125 | 4,130 | 3,600 | 3,660 | 3,520 | 4,120 | 1,900 |
| Cathodic current den. at rating—amps./sq.m. | | 980 | 1,330 | 3,750 | 4,750 | 5,330 | 5,580 | 4,000 | 4,000 | 3,460 | 3,480 | 3,350 | 3,690 | 1,900 |
| Avg. overall cell voltage at rating | | 3.75[2] | 3.83 | 4.72[2] | 4.50 | 4.34 | 4.41 | 4.32[2] | 4.32 | 4.25[2] | 4.25 | 4.20[2] | 4.40 | 4.3 |
| Avg. overall cell voltage—max. amps. | | 4.02[2] | 3.95 | 5.13[2] | 4.75 | 4.52 | 4.56 | 4.58[2] | 4.58 | 4.50[2] | 4.50 | 4.50[2] | 4.70 | 4.5 |
| Current eff. % (NaOH) | | 96 | | 95 | | 96+ | | 93-97 | | 94-96 | | 94-96 | | 98-97 |
| Current eff. % (KOH) | | | | | | | | 92-94 | | 92-94 | | 92-94 | | 94-96 |
| Shunt-circuiting switches | | parabola every 50 cells | | every 2 cells | | none used[3] | | 4 unit[3] | 8 unit[3] | 4 | 4 unit[4] | 14 unit[4] | 18 unit[4] | parabola every 25 cells |
| Merc. pump power—kw. | | 0.25 | | 1.12 | | 0.40 | 0.65 | 0.28 | 0.50 | 1.2 | 1.6 | 0.8 | | 1.5 |
| Power d.c.—kw.-hr./ton $Cl_2$—rating | 2,690 | 2,740 | | 3,400 | 3,250 | 3,130 | 3,180 | 3,120 | 3,120 | 3,250 | | 3,025 | 3,175 | 3,100 |
| Power d.c.—kw.-hr./ton $Cl_2$—max. amps. | | | | | | 3,226 | 3,290 | 3,310 | 3,310 | ? | | 3,250 | 3,400 | 3,290 |
| Cathode width—in. | 1.37 | 1.48 | | .456 | .615 | 1.29 | 1.29 | 0.92 | 1.25 | 1.25 | 1.43 | 1.07 | 2.12 | 0.83 |
| Cathode length—in. | 1.52 | 1.65 | | 8.8 | 10.2 | 13.96 | 23.60 | 10.87 | 16.0 | 9.40 | 16.20 | 11.20 | 14.40 | 0.83 |
| Cathodic area—sq.in. | 10.2 | 20.4 | | 4.03 | 6.30 | 18.0 | 30.44 | 10 | 20 | 11.56 | 23.00 | 12.00 | 30.5 | 21.0 |
| Cell dimensions—over-all without sides-in. width | 1.37 | 1.48 | | 7.6 | 9.0 | 1.59 | 1.59 | 1.55 | 1.64[3] | 1.58 | 1.91 | 1.38 | 2.47 | 1.26[10] |
| Cell dimensions—over-all without sides-in. length | 1.52 | 1.52 | | 10.4 | 12.2 | 16.55 | 25.83 | 12.33 | 17.58 | 12.8 | 19.7 | 12.2 | 16.0 | 1.10[10] |
| Floor space per cell—inc. sides-sq.m. | 4.9 | 7.0 | | 19.8 | 23.7 | 29.8 | 46.4 | 32.0 | 38.0 | 33.0 | 53.0 | 30.2 | 65.0 | 13.90 |
| Floor space per daily ton $Cl_2$—sq.m. | 21.0 | 8.9 | | 40.4 | 24.7 | 9.85 | 8.86 | 23.6 | 23.2 | 26.4 | 21.2 | 24.2 | 17.1 | 10.8 |
| Headroom req'd. for piping, etc. under cells—approx. | 0 | 0 | | 4.55 | 4.55 | 5.70 | 5.70 | 3.30 | 3.30 | 1.44 | 2.29 | 2.70 | 3.20 | 0[11] |
| Ft. above 2nd floor level—in. | 0 | 1.6 | | 0.90 | 0.90 | 1.70 | 1.70 | 1.30 | 1.40 | | | 0.30 | 0.40 | 3.0[11] |
| Adjustable anodes | no | | | yes | | yes | | yes | | yes | | yes | | no |
| Anode stem diaph. material | | | | rubber | | graphite[7] | | packing | | rubber-asbestos | | rubber-asbestos cell top | | |
| Cell channel under load | no | | | no | | yes | | no | | no | | no | | no |
| Slope of cell bottom—mm./m. | | | | 3 | | 6 | | 4 to 5 | | 2 to 3 | | 4 | | |
| Decomposer—type | | | | vertical | | horizontal | | horizontal | | horizontal | | vertical | | vertical |
| Decomposer—location | | | | at end of cell | | under cell | | at side | at side[9] | under cell | | at end of cell | | at side of cell |
| Decomposer—lining | | | | none | | none | | none | | rubber | | none | | none |
| Sodium content entering decomposer—% | | | | 0.15 | | 0.70 | | 0.20-0.25 | | 0.15 | | 0.12-0.15 | | 0.03-0.10 |
| Cell construction—bottom | concrete | | | bare steel | | bare steel | | bare steel | | rub.-covered steel | | stone-lined steel elect. contacts | | steel-rub.-covered |
| Cell construction—sides | concrete | | | rub.-covered steel | | rub.-covered steel | | rub.-covered steel | | rub.-covered steel | | stone | | rub.-covered steel |
| Cell construction—top | concrete | | | rub.-covered steel-one piece | | rub.-covered steel sliding sect. | | rub.-covered steel 2 sect. | 4 sect. C-clamps | rub.-covered steel 1 pc. | 3 sec. bolts | ¼-in. flexible rubber | | rubber |
| Method of securing top | gravity | | | C-clamps | | inflatable rub. gasket | | C-clamps | | bolts | | bolts | | bolts |
| No. anodes width of cell | | | | 1 | | 4 | 4 | 2 | 2 or 3 | 2 | 2 | 3 | 6 | 3 |
| No. anodes per cell | | | | 22 | | 108 | | 74 | 1 | 52 | 1 | 42 | 18 | 48 |
| No. stems per anode | | | | 2 | | | | | | | | 2 | 2 | 1 |
| Anode wt. per cell (inc. stems) lbs. | 800 | | 1,500 | 960 | 1,400 | 6,230 | 13,300 | 2,800 | 5,600 | 3,300 | 6,270 | 3,380 | 8,940 | 2,200 |
| Decomposer graphite—wt. per cell, lbs. | | | | 195 | 300 | 800 | 1,330 | 200 | 400 | 550 | 850 | 800 | 1,800 | 660 |
| Mercury wt. cell lb. | | | | 1,900 | 3,100 | 4,600 | 7,300 | 2,800 | 5,600 | 3,200 | 5,800 | 3,200 | 8,000 | 2,280 |
| Mercury wt. for 100 tons/day plant—in lbs. | | | | 388 | 322 | 152 | 139 | 224 | 224 | 256 | 232 | 250 | 204 | 190 |
| Copper wt. cell inc. bus bars-lbs. | | | | | 2,000 | 4,100 | 6,850 | 2,820 | 7,980 | 4,500 | 9,000 | 2,400 | 8,000 | 880 |
| Total wt. of cell in operation-lbs. | 8,700 | 16,000 | | 13,200 | 19,500 | 50,000 | 80,000 | 34,000 | 62,000 | 22,000 | 40,000 | 50,000 | 80,000 | 22,000 |
| Anode life—m.-KOH | | | | | | 6.4 | 9.6[8] | | 7 to 8 | 8.9 | | 12 | 10 | 7 |
| Anode life—m.-NaOH | 12 | 10 | | 10 | 7 | 8.0 | 12.0 | | 11 to 12 | | | 14 | 12 | 8 |
| Graphite consumption/ton KOH-lbs. | 7 | | | | | 7.3 | 7.6 | | 8 | 7 | | | | 7.0 |
| Graphite consumption/ton NaOH-lbs. | 6.0 | 4.7 | | 5.3 | 5.3 | 8.15 | 8.50 | | 3.0 | 5.0 | | | 4.0 | 4.0 |
| Mercury consumption—lbs./ton $Cl_2$ | | | | | | | | 0.3-0.5 | | 0.25-0.30 | | 0.3 to 0.5 | | 0.3-0.5 |
| $Cl_2$ %—dry basis—KOH | | | | | 0.5 | 0.3 | | 99 ± 1 | | | | | 98+ | 99+ |
| $H_2$ in $Cl_2$ %—dry basis—KOH | | | | | | | | 1.5 ± 0.5 | | | | | 0.5-1.0 | 0.1 |
| $Cl_2$ %—dry basis—NaOH | 0.3 | | 0.2 | | | 97.0 | | 99.0 ± 0.2 | | 98.5 | | | 99+ | 99+ |
| $H_2$ in $Cl_2$ %—dry basis—NaOH | 0.3 | | 0.2 | | | | | 0.2-0.6 | | 0.45 | | | 0.2-0.5 | 0.1 |
| $N_2$ %—dry basis—NaOH | | | | | | 99.5 | | 99.7 ± 0.2 | | | | | 99.8 | 99.8 |
| Relative cost inc. copper bus—$ | | | | | | | | | | | | 960,000 | 840,000 | 600,000 |

[1] Not available for license in U. S. since October, 1955. [2] 2.04 m. with decomposer alongside. [3] manually placed short-circuiting links used for major cell repairs. [4] gang switch, manually operated. [5] gang switch, operated by relay from mercury pump motor automatically. [6] gang switch, air actuated. [7] anode stem passes through graphite "diaphragm" providing seal and electrical contact. [8] V-200 cell uses thicker anodes than the V-100. [9] location under cell optional. [10] cell only (without decomposer); [11] decomposer (cell only, 1.3 m.). [12] Voltages are guaranteed and include all busbar voltage drops in d.c. circuit

The vertical cell must be completely dismantled for anode, diaphragm, and cathode changes. de Nora estimates that such overhaul may be necessary once between anode changes, perhaps every seven to eight months. All the cell parts are small in size but there are a large number of them—certainly a step in the wrong direction. The trend in all other cells is to the smallest number of the largest size parts. Even though the actual weight of materials is only one third that of the horizontal, a larger proportion must be handled during disassembly.

The horizontal cell requires what amounts to a two-story building but the vertical, like the Hooker, can be put into a one-story building and this is a considerable advantage.

**Conclusion**

It is concluded that the trend is away from diaphragm cells to the much larger mercury cells for new and for expanded plants because the capital and operating costs are in general less, and the purified diaphragm caustic, while satisfactory for most purposes, can not quite compete with caustic from mercury cells in purity.

Even though there are negative factors and yet-to-be proven commercial operation, it is the considered opinion of this observer that the vertical cell is an important forward step which might make the horizontal cell development, which has proceeded about as far as it can, technically obsolete in a few years.

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*Presented at A.I.Ch.E. meeting, Seattle, Washington.*

*Part 2, containing Tables 1 and 2, will be published in October.*

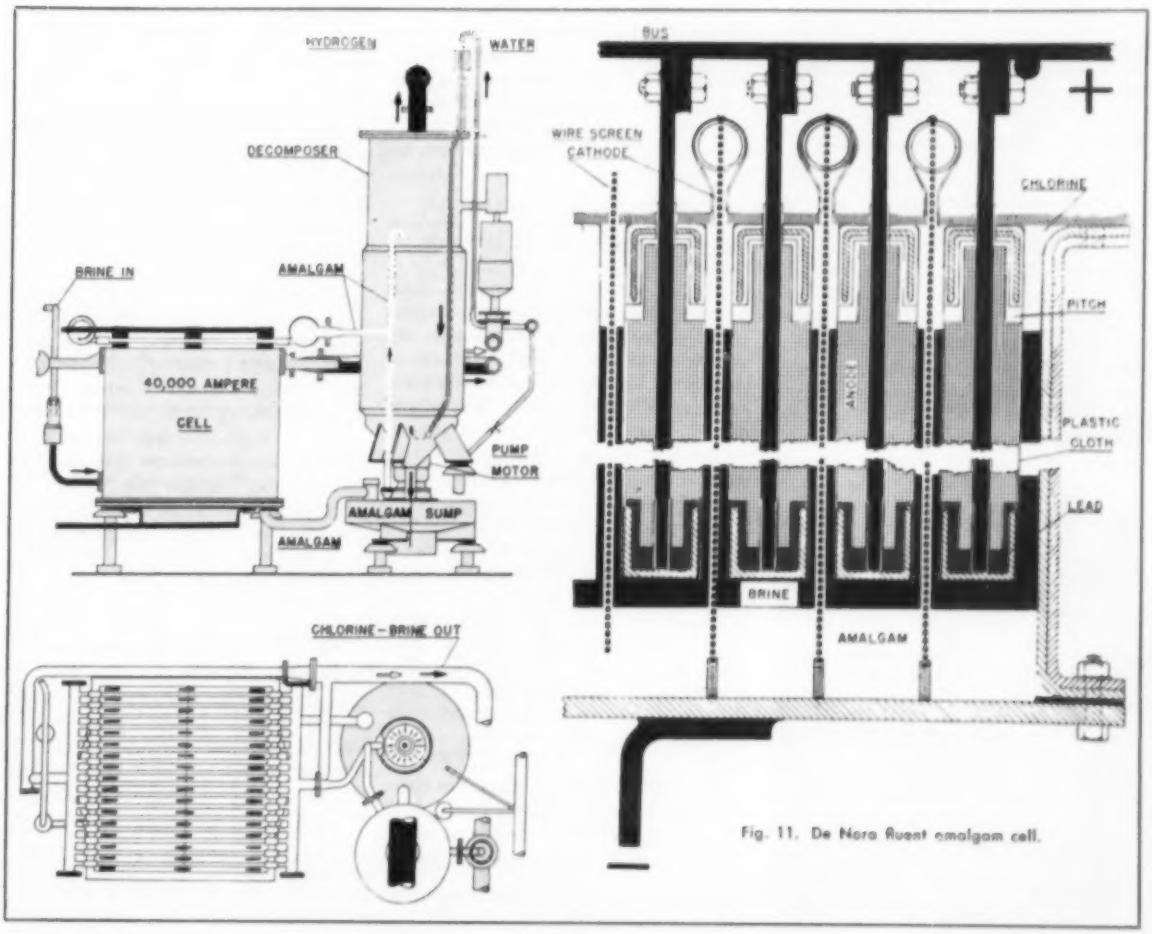



Fig. 11. De Nora fluent amalgam cell.

**Conversion of alternating to direct current power has been accelerated with the increasing demands on our present-day chemical industry. Alternating current today is being converted in many ways but the principal ones are the mercury arc rectifier, selenium or copper oxide rectifier, the motor generator set, the synchronous converter, and the mechanical rectifier. The last named, the subject of this article, has shown consistently high efficiency and economic value. The authors believe that its maintenance costs are substantially below those on a motor generator set and little more than those on a mercury arc rectifier.**

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Becco Chemical Division, Food Machinery & Chemical Corp., Vancouver, Washington

## ECONOMY OF OPERATION AND MAINTENANCE OF

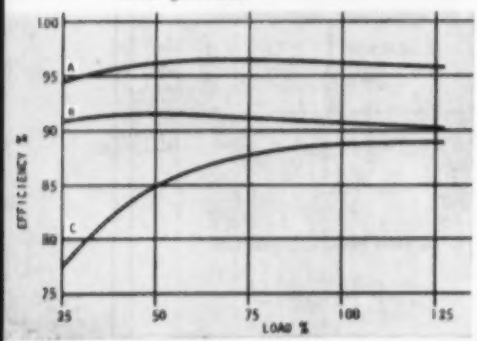
# MECHANICAL RECTIFIERS

In 1952 four 5,000 amp., 280 v. d.c. mechanical rectifiers * were put into service at the Becco Chemical Division's Vancouver, Washington, plant for the electrolytic production of hydrogen peroxide. These units have operated almost continuously on an around-the-clock basis since they were installed. In addition, in 1956 two more rectifiers of the same type were installed in an expansion program.

### History and Use of Converted Power

Based upon the performance shown by mechanical rectifiers, both 25 and 60 cycle, which had been in service for a number of years in the Buffalo plant—the first in the United States to use mechanical rectifiers—the decision was made to use this type of equipment in Becco's Vancouver plant. This plant manufactures only one product—hydrogen peroxide—in the production of which there are two principal phases: namely, the electrolysis of a carrier solution and the hydrolysis and distillation of this carrier solution. The concern of this article is primarily with the first phase of this operation.

Fig. 1. Comparison of conversion efficiencies. A—1,500 kw. 280 v. mechanical. B—1,500 kw. 280 v. ignitron. C—1,500 kw. 280 v. motor generator.




### The Process

A solution of ammonium sulfate, sulfuric acid, and water is passed through a series of cells and is electrolyzed on a platinum anode. The electrolyzed solution then contains ammonium persulfate, sulfuric acid, and water. The important reaction is as follows:

$$2NH_4HSO_4 \rightarrow (NH_4)_2S_2O_8 + H_2.$$

The equivalent hydrogen peroxide is formed at the rate of about 1.4 lb./1,000-amp. hr. It is evident that a product that sells for almost 50¢/lb. on 100% basis power, which must be purchased at about three mills/kw.-hr., should be used as economically as possible. It may be readily ascertained that each per cent increase in power conversion efficiency will yield a 1% increase in production of hydrogen peroxide, less, of course, some electrolysis and distillation losses.

Because the company's cell lines were designed for a voltage drop of approximately 280 to 300 v., it was necessary to find equipment which would give peak efficiencies at this particular voltage, and which would not require an appreciably larger capital investment than was required by other types of conversion equipment.

In Figure 1 a comparison has been made of the conversion efficiencies of 1,500 kw. mechanical rectifiers, mercury arc rectifiers or ignitrons, and a motor generator set. At 100% load the percentage efficiencies for the three types are: mechanical rectifiers, 96.5; mercury arc rectifiers, about 91.5; motor generator, about 89. At 75% load the percentage efficiencies are: mechanical rectifier, still just over 96; the mercury arc about 91.5; and the motor generator about 87.5. Should the productivity of a plant be reduced to 75% of its rated capacity, no marked reduction in efficiency of conversion would occur with mechanical rectification. A motor generator falls in efficiency quite rapidly when less than 75% of the load is used.

These plots were made specifically for conversion equipment used at approximately 280 to 300 v. These curves would not, of course, hold if a substantially higher voltage were used, for if double the voltage were used, or 560 to 600 v., the mercury arc rectifier would compare much more favorably with the mechanical rectifiers, their principal loss being an almost constant voltage drop through the cathode. As the use voltage increases, the voltage drop becomes proportionately smaller and at about 600 v. a mercury arc rectifier has an efficiency of about 96%.

### Layout of Power Station

In determination of the type of equipment to be used, not only is efficiency important, but the investment cost of the selected equipment and its housing needs are also of vital concern.

As indicated in Figure 2a, the power station is a compact, clean, and well-organized layout. The total space required for these six units is approximately 63 ft. long by 20 ft. wide with the rectifier

* Equipment described in this article is the I-T-E mechanical rectifier.

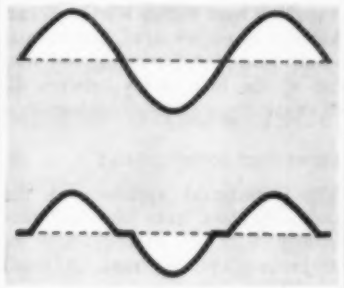


Fig. 5. Normal voltage sine wave modified by a commutating reactor.

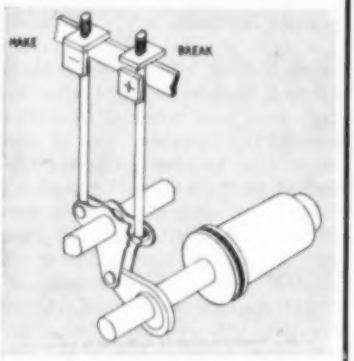



Fig. 6. (above): The contact mechanism. Fig. 7-8 (below): Production of continuous voltage from modified sine wave.

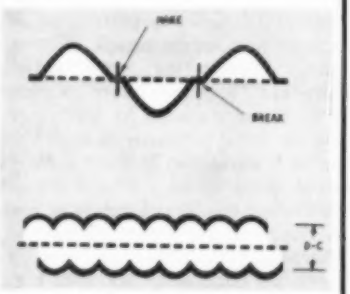





Fig. 3. The 1,700 kva., 12,000 v. oil-cooled transformers.

cubicle and associated switchgear panels using 1,160 sq. ft. The building housing this station is steel reinforced concrete throughout with 15-ft. ceiling. Room is required below the station for the electrical conduit, which can be laid either in the ground or, as at Becco, in a cellar below the main floor.

In Figures 2 and 2a the location of the rectifiers, d.c. switchgear, and a.c. switchgear is indicated. Figures 2, 2a, and 3 show the layout of the rectifiers plus the 1,700 kva., 12,000 v. oil-cooled transformers. The area needed for the transformers is 15 ft. by 43 ft. by 10 ft. high. The two smaller transformers in the upper right-hand corner of Figure 2a are lighting and auxiliary power transformers.

### Mechanical Rectifier

Figure 4 shows a 5,000 amp. I-T-E mechanical rectifier, with the a.c. disconnect switch, plus covered contact mechanism and d.c. bus with associated leads. The synchronous drive motor and regulator are at the right of the unit. The cubicle (in the illustration), ventilating fan, and hoses leading from the lower part

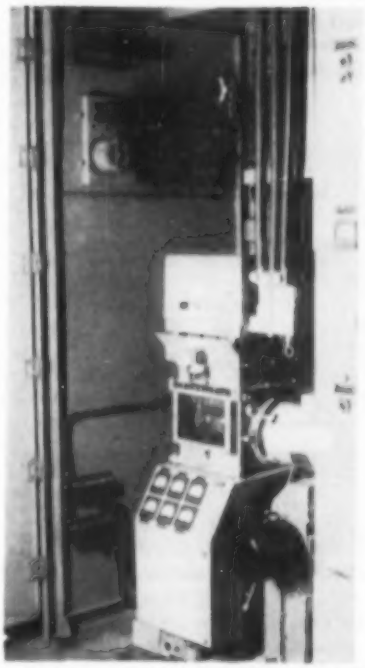
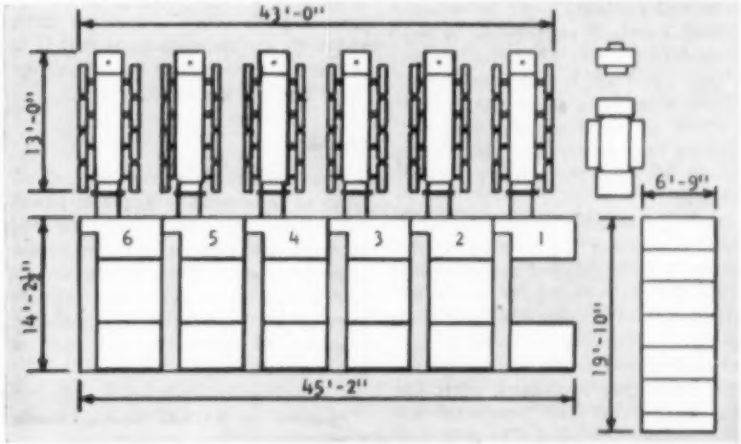


Fig. 4. View of 5,000 amp. I-T-E mechanical rectifier.

Fig. 2. (right): Arrangement of rectifiers, d.c. and a.c. switchgear. Fig. 2a (below): Power station layout. Sq.ft. o.s.—559; sq.ft. i.s.—1,160; height o. s.—9 ft. 1½ in.; height i. s.—10 ft.






to the upper part of the machine for oil circulation can also be noted. This oil serves the dual purpose of lubricating and cooling. The rectifier is mounted on leveling screws during operation. However, for necessary maintenance outside the cubicle, the attached wheels are employed.

Essentially a motor-actuated switch, the mechanical rectifier, with the necessary auxiliary equipment, converts alternating to direct current. In extremely simplified form a conversion is accomplished by taking a normal voltage sine wave and modifying by the use of a commutating reactor (Figure 5). When the contact mechanism (Figure 6) makes and breaks contact, as indicated in Figures 7-8, the result is a continuous voltage. The heart of the rectifier is a contact mechanism which holds each individual contact in proper relationship with

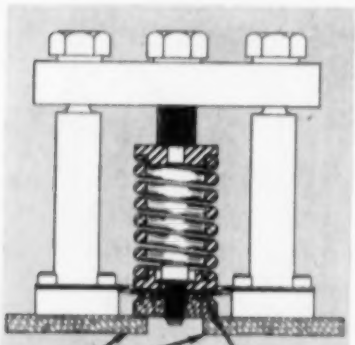



Fig. 9. Component parts of spring-loaded contact.

the alternating and direct current bus bars. Component parts of a spring-loaded contact are shown in Figure 9. The mechanism has one a.c. and one d.c. stationary contact, both 1 in. wide by 2 in. long, and one moving contact 1⅛ in. diam. All parts are enclosed or attached to the plastic housing. During operation the center bridging surface, which is actuated by a push rod mechanism, makes and breaks contact over one million times an hour.

## OPERATION AND MAINTENANCE

The mechanical rectifier requires a short period of operation and adjustment prior to being put on the line. Since it is a semiautomatic mechanism, it requires a minimum of attention in operation. Operators of this type of equipment should have normal industrial experience but need not be especially well versed in electrical machinery. The starting and stopping sequences can be learned in a fairly short instruction period. During operation, a periodic check of the rectifier and transformer is performed to determine contact condition and running characteristics. Maintenance personnel should have a more thorough knowledge of the internal parts and function of the mechanism.

In the operation of the unit a start-up pattern is established which assists greatly in determining if the rectifier is operating properly and is ready to be put on the line. This sequence includes starting of the mechanism drive motor, the regulator, oil pump, and cubicle ventilation fans. The rectifier is next supplied a base load and, with the use of an oscilloscope and voltmeter, the make-and-break characteristics of each contact are determined. When the check points are considered satisfactory, the unit is put on the line by necessary switching and adjusting to the required load.

In operation the rectifier is considered noisy due to the opening and closing of the contacts and auxiliary equipment. Troubles may ocur with mechanical rectifiers if the incoming a.c. voltage varies a great deal. Backfires have occurred in Becco's rectification equipment when incoming voltage rose more than 6% without proper adjustment of the machine. What would now be considered a recommended practice when installing mechanical rectifiers is the added installation of a voltage regulator. Such a regulator, with a 5% buck and boost, has been installed by Becco. This regulator compensates for any line changes made by the substations at night when their line voltage is reduced and changes made in the morning when their line voltage is increased. The addition of such a voltage regulator will markedly improve the operating characteristics of the mechanical rectifiers.

Rated overload capacity of a mechanical rectifier is 150% for 1 min. If this overload is sustained, sympathetic outage can occur. At as high as 110% of rated capacity however, backfires have occurred in single units without affecting the other paralleled rectifiers.

During a backfire or planned shutdown a sequence the reverse of the start-up is accomplished automatically except for the opening of associated switchgear. The contacts are then checked for burning or metal fusing, and replacement is made when necessary. The other component parts are also investigated and repair or replacement accomplished. The unit then can be readied for line service and can carry a load within 5 min. When a backfire is encountered, the normal over-all time for returning the machine to the line varies between 10 and 15 min.

## BACKFIRE AND CONSEQUENCES

The mechanical rectifiers at the Vancouver plant have operated continuously with an average time of 1,000 hr. over a year's period. As much as 2,470 hr. have been logged on a mechanical rectifier without backfire and higher contact time than this is expected. Normally, after a backfire, the contacts are changed at a current replacement cost of $5.00 per contact, but contacts only damaged after an outage have been returned to service successfully. However, use of new contacts after backfire has been established as good operational procedure; therefore, an adequate stock of contacts should be maintained. In Vancouver 24 sets are maintained for six machines. Over a twelve-month period 444 contacts were used. Other parts that will eventually wear are the bearings and slip rings of the synchronous drive motor and associated equipment. The replacement cost of parts during the last five years is not considered excessive. Preventive maintenance for the past year per machine was approximately 10 man-hours. During the same period, thirty-four backfires were encountered: 15 were caused by faulty contacts attributed primarily to high voltage and excessive load; 12 power source disturbances; 3 synchronous drive motor troubles; 1 regulator malfunction; and 3 auxiliary power fuse.

Because the capital costs of a hydrogen peroxide plant are quite high, it is extremely important that the operating costs be kept relatively low. It is felt that the mechanical rectifier has given us a high efficiency rectified current at a capitalization cost comparable with other conversion units and with maintenance costs that it is believed are no higher than those for other types of conversion units.

**Summary**

The Buffalo plant has operated all types of commercially available power conversion equipment including the mercury arc rectifier and the motor generator set. The conclusion is drawn that the mechanical rectifiers have shown remarkable dependability, economy of operation, and ease of maintenance.

*Presented at A.I.Ch.E. meeting, Seattle, Washington.*

## some industrial aspects of

# PACIFIC NORTHWEST AND ALASKAN HYDROELECTRIC POWER

**The authors believe that the enormous untapped electric power potential of British Columbia and Alaska brings these regions into prime consideration for electroprocess industry expansion and new plant establishment during the coming ten years.**

*Ivan Bloch and John H. Davidson*

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Electroprocess industry requirements for power supplies have continued to grow at high rates. The outlook for future requirements of those industries is for unabated growth in all of them, with particular emphasis on the share taken by the light metals. Forecasts for these requirements will be given in detail.

Traditionally, electroprocess industries have selected under-developed areas with hydroelectric potential as their first choice for plant location. However, as these areas have become developed, the pressures of demands for power to satisfy residential and manufacturing requirements have gradually tended first to restrict expansion of those electroprocess industries, and then to cause them to seek other locations for establishment and expansion. This has taken place in the Niagara Falls area and, more recently, in the Pacific Northwest. During the past two decades, these electroprocess industries selected the Pacific Northwest because of its then-enormous potentials of low-cost hydroelectric energy, and a price for that energy which offsets the costs of transportation to distant markets.

During the past few years, however, restrictions on the growth of power supplies in the Pacific Northwest have confined expansion and new plant establishment to other parts of the nation in which higher power costs are offset by lower transportation costs to market. Mine-mouth plants of enormous size are being constructed.

The question as to the power outlook in the Northwest and the North Pacific areas is one of time. It is contended that electroprocess industries will again consider these areas for major plant establishment, particularly the enormous untapped potential of British Columbia and Alaska.

### Importance of Power to Electroprocess Industries

By definition, electroprocess industries employ electric power either electrolytically or electrothermally in the production of such materials as aluminum, magnesium, chlorine, calcium carbide, and a host of other substances. In all instances, the power requirements of electroprocess industries have the same general characteristics: the unit quantities are large; the

**Table 1.—Forecasts of Electroprocess Industry Growth**

| Electroproduct | Annual production (thous. tons) 1960 | 1975 |
|---|---|---|
| Primary aluminum | 2,300 | 5,500 |
| Primary magnesium | 110 | 500 |
| Primary titanium | 80 | 1,000 |
| Artificial abrasives: | | |
| Fused alumina | 250 | 375 |
| Silicon carbide | 100 | 175 |
| Calcium carbide | 1,100 | 2,000 |
| Chlorine | 5,000 | 12,000 |
| Elemental phosphorous | 400 | 700 |
| Ferro-alloys | 2,700 | 4,000 |

**Table 2.—Some Forecasts of Electroprocess Industry Power Requirements**

| Electroproduct | Forecast annual production (thous. tons) 1960 | 1975 | kwh./ton | Electric power requirements: Millions of kwh. 1960 | 1975 | Thousands of kw. 1960 | 1975 |
|---|---|---|---|---|---|---|---|
| Aluminum ingot | 2,300 | 5,500 | 17,000 | 39,100 | 93,500 | 4,520 | 10,800 |
| Magnesium ingot | 110 | 500 | 18,000[1] | 1,980 | 9,000 | 228 | 1,040 |
| Titanium sponge | 80 | 1,100 | 35,000[2] | 2,800 | 35,000 | 336 | 4,210 |
| Fused alumina | 250 | 375 | 2,800 | 700 | 1,050 | 84 | 121 |
| Silicon carbide | 100 | 175 | 8,600 | 860 | 1,505 | 104 | 181 |
| Calcium carbide | 1,100 | 2,000 | 3,100 | 3,410 | 6,200 | 410 | 745 |
| Chlorine | 5,000 | 12,000 | 2,900 | 14,500 | 34,800 | 1,670 | 4,010 |
| Elemental phosphorous | 400 | 700 | 13,000 | 5,200 | 9,100 | 625 | 1,095 |
| Ferro-alloys | 2,700 | 4,000 | 6,000[3] | 16,200 | 24,000 | 1,950 | 2,890 |
| Total of above | | | | 84,750 | 214,155 | 9,927 | 25,092 |
| Total U. S. power requirements[4] | | | | 779,900 | 1,523,500 | 143,900 | 280,800 |
| Power requirements of above electroprocess industries as % of total U. S. requirements | | | | 10.8% | 14.0% | 6.9% | 8.9% |

[1] For electrolytic process or silico-thermic process.
[2] Including regeneration of magnesium or sodium and chlorine.
[3] Estimated average power requirement.
[4] Source: U. S. Federal Power Commission (1).

supply must be constant and capable of substantial expansion for future plant requirements; and as pointed out further on, must be of the lowest unit price.

For the purposes of this presentation, some of the estimates made for Government agencies are presented. Charts are included which graphically portray trends and forecasts of some major electroprocess industries in the United States (pp. 425, 427). Table 1 summarizes the estimates for primary aluminum, artificial abrasives, calcium carbide, chlorine, ferro-alloys, primary magnesium, elemental phosphorous, and primary titanium—chosen as representative of the many electroproducts in commercial production at this time.

In general, the trend in these industries continues sharply upward for many years into the future. Growth has been dramatic because of the importance of all of the materials produced, whether chemical or metallurgical, in the maintenance of our modern civilization.

Table 2 summarizes unit requirements for power for each of eight major electroprocess industries, together with estimates of their total energy requirements in millions of kilowatt-hours forecast for the years 1960 and 1975. An approximation of total capacity requirements in thousands of kilowatts is also presented.

The total energy and capacity requirements for these eight industries (and we must note that these are only a portion of total electroprocess industry requirements, which include such other important items as electric steel, electromanganese, silicon metals, and many others) can be compared with United States energy and capacity requirements forecast for these same years. The total energy requirements for these eight major electroprocess industries represent almost 11 per cent of total U. S. electrical energy requirements for the year 1960 and 14 per cent by 1975.

These percentages, which understate total electroprocess industry power requirements, are obviously very great, and the trend of requirements is clearly upward.

**Table 3.—Relation of Power Price to Sales Price for Selected Electroproducts**

| Electroproduct | Sales price ($/ton) | Cost of power/ton of product and % of sales price for various unit power prices: @ 2 mills/kwh. | | @ 4 mills/kwh. | | @ 6 mills/kwh. | |
|---|---|---|---|---|---|---|---|
| Aluminum ingot | $ 542.00 | $34.00 | 6.3% | $68.00 | 12.6% | $102.00 | 18.9% |
| Magnesium ingot | 705.00 | 36.00 | 5.1 | 72.00 | 10.2 | 108.00 | 15.3 |
| Titanium sponge | 5,500.00 | 70.00 | 1.3 | 140.00 | 2.6 | 210.00 | 3.9 |
| Calcium carbide | 134.00 | 6.20 | 4.6 | 12.40 | 9.3 | 18.60 | 13.9 |
| Chlorine | 63.00 | 5.80 | 9.2 | 11.60 | 18.4 | 17.40 | 27.6 |
| Elemental phosphorous | 380.00 | 26.00 | 6.8 | 52.00 | 13.7 | 78.00 | 20.5 |
| Ferro-alloys[1] | 354.00 | 14.00 | 2.5 | 28.00 | 5.0 | 42.00 | 7.5 |

[1] 70% ferrochromium, which requires 7,000 kwh./ton.

### Importance of Power Price

The price of power, because of the very great unit requirements, is obviously critical in electroprocess industry operations. Table 3 presents a few calculations for some major electroprocess industries, showing the relation of power price to sales price. At two mills/kwh.—and there are very few places where such low-priced power is available—the equivalent cost of power ranges from 1.3% of sales price for titanium sponge to 9.2% of sales price for chlorine. At 6 mills/kwh., the range of power price to sales price jumps sharply from slightly under 4% for titanium sponge to almost 28% for chlorine.

As might be expected, the percentage of power price to production costs is much greater. In the case of aluminum metal, a two mill power price represents 13% of total production costs; four mills, 23%; six mills, 33%. Somewhat similar relations exist for other electroprocess materials.

**The combination of power supply requirements which are basic to the establishment and expansion of electroprocess industries has been regarded as onerous by most power suppliers in various parts of the United States. Unit prices must be very low to be attractive to these large power consumers. Minimum-sized plants frequently consume as much energy and require as much generating and transmission capacity as all the other consumers on any particular system. As a consequence, managements of power systems prefer the more mundane (and more directly profitable) business of serving domestic, commercial, and small industrial consumers.**

This is not a new situation. It has been typical of the history of electroprocess industries in the United States. Quite frequently, the business community has been unwittingly drawn into campaigns of various degrees of subtle (and not-so-subtle) opposition to electroprocess development. Arguments are monotonously similar: it is said that electroprocess industries are relatively low employers of labor per unit of required electrical capacity: hence, the power resources of an area should be devoted more "effectively" to the development of "payroll-producing industries." Or, it is said that "low-cost power is not important to industrial development": hence, upward adjustments of power rates are not a deterrent to industrial operations. Or, it is said that firm power (available 8,760 hr./yr.) is not important.

No analysis of future electroprocess industry expansion and location can ignore the attitudes of power suppliers and of the communities or areas involved. It can be observed, therefore, that the establishment of electroprocess industries—until very recent years




Fig. 1. Major existing and potential hydroelectric power projects in the Pacific Northwest.

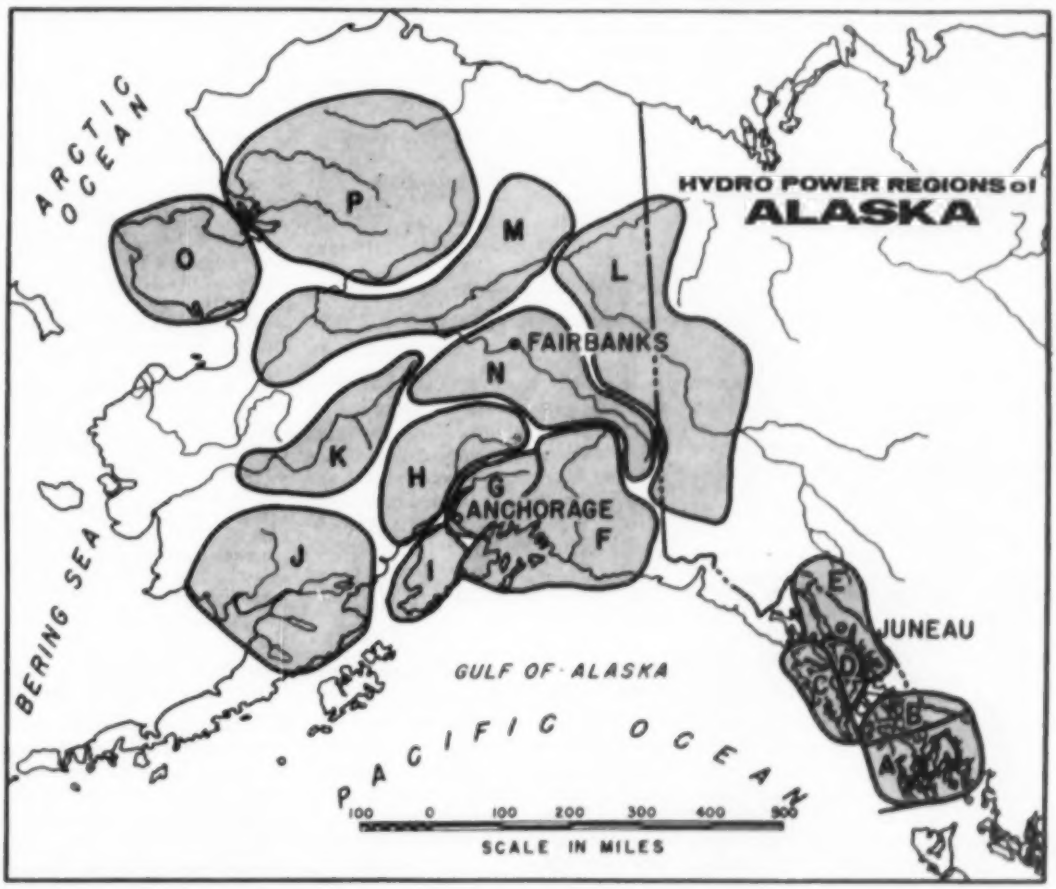



Fig. 2. Major hydroelectric regions of Alaska. (See Table 7, p. 426, for estimated capacities.)

—has been in those areas having hydroelectric potential, but of relatively low developmental status. Witness the Pacific Northwest as a principal example of recent electroprocess industry concentration. Hydroelectric power supplies, as at Niagara and the Tennessee Valley, were of the lowest price, the greatest reliability as to continuity of supply, and in such quantities as to make expansion relatively certain. The word "relatively" is used deliberately. Thermal-electric power production—until very recent years—was of slight interest due to limitations in generating capacity and availability, and uncertainties in the price of power.

In most large steam-electric plants, operating costs represent perhaps as much as 80% of total price per unit of power at bus bar. In hydro plants, operating costs are as little as 10% of total price. Since operating costs for steam-electric plants are mainly composed of fuel costs, the price of power is primarily dependent on fuel price and availability. Most of the power price from hydroelectric plants is attributable to capital charges (amortization and interest on investment) so that a stable rate structure is usually possible.

During the past decade, some notable changes have taken place in the location of the larger units of electroprocess industries. This is owing partly to the fact that the better hydroelectric sites have been fully developed in the traditionally hydro-rich areas such as Niagara Falls and the Tennessee Valley. In the Pacific Northwest, the schedules of exploitation of its many remaining sites have been falling seriously behind growing demands for power in the region. Furthermore, policies, terms, and conditions governing power contracts have definitely prevented expansion or establishment of electroprocess industries.

Because of this situation, a substantial portion of new electroprocess industry establishment has taken place during the past decade in the Gulf Coast area, based on the availability of low-priced natural gas fed into huge gas engine electric generation installations, and in the eastern coal regions where very large steam-electric plants are being established at coal mine-mouth. This has taken place in spite of the fact that power prices from thermal generating plants have been usually much greater than those heretofore available from large hydroelectric installations. This seeming contradiction finds explanation in the relation between power costs and transportation costs. Stated in simplest terms, higher power costs can be partly offset by lower transportation costs. Or, conversely, lower power costs serve to offset higher transportation costs.

**Table 4.—Comparison of Certain Freight Rates Applicable to the Aluminum Industry**
**(Including 3% Federal Transportation Tax)**

| | Total freight rate cost/ton of product | |
|---|---|---|
| | 1952 | June 1957 |
| **Freight rates** | | |
| Alumina | | |
| Baton Rouge, La., to Spokane, Wash. | $10.88 | $12.10 |
| Baton Rouge, La., to Ravenswood, W. Va. | ..... | 11.12 |
| Ingot | | |
| Spokane, Wash., to Detroit, Mich. | 25.56 | 27.69 |
| Ravenswood, W. Va., to Detroit, Mich. | ..... | 12.77 |
| Sheet and extrusions | | |
| Spokane, Wash., to Detroit, Mich. | 46.91 | 49.40 |
| Ravenswood, W. Va., to Detroit, Mich. | ..... | 11.74 |
| **Total freight costs** | | |
| Ingot | | |
| Spokane, Wash., to Detroit, Mich. | 47.32 | 51.89 |
| Ravenswood, W. Va., to Detroit, Mich. | ..... | 35.01 |
| (Differential) | | (16.88) |
| Sheet and extrusions | | |
| Spokane, Wash., to Detroit, Mich. | | 73.60 |
| Ravenswood, W. Va., to Detroit, Mich. | | 33.98 |
| (Differential) | | (39.62) |

### Relation of Power and Transportation Costs

In the case of Pacific Northwest electroprocess plants, the unusually low power costs (based on a $17.50/kw.-yr. rate, equivalent to 2 mills/kwh. at 100% annual load factor) have offset high transportation costs of raw materials or products to markets in the East. Similarly, higher power costs from thermal-electric installations as in the Ohio Valley (stated to be in the neighborhood of 4 to 5 mills/kwh.) are offset by low freight rates to nearby markets. This situation is illustrated by the present freight rates applicable to raw materials and end-products of certain aluminum plants in the Pacific Northwest and in the Ohio Valley. These rates are shown in Table 4.

From this table, it can be seen that, regarding aluminum ingot (including alumina cost increment), there is a transportation cost differential of $16.88 between Pacific Northwest production and production in the Ohio Valley. By reference to Table 3, it can be noted that this transportation cost differential is just about equivalent to a power price differential of 1 mill/kwh. Stated in other words, 3 mill power in the Eastern coal region can compete with 2 mill power in the Pacific Northwest for aluminum reduction operations.

In the case of aluminum extrusions and sheet, however, the transportation cost differential (shown in Table 4 to be $39.62) is equivalent to approximately a 2½ mill power price differential. Again, this means that 4½ mills power price in the eastern coal region can compete with Pacific Northwest 2 mill power. (There are other differences to be accounted for which may vary these differentials, but the principle and general level of comparison would not be greatly changed.)

There is, of course, another factor to which long-term attention is necessary regarding these transportation cost differentials. This is the continual upward trend in rail freight rates. Reference to Table 4 shows that since 1952, total freight rates applicable to aluminum ingot originating in the Pacific Northwest for markets in the Detroit area (as an example) have risen 9.7%. For sheet and extrusions, the increase from 1952 to the present time was slightly over 7%. Although these are negotiated freight rates, there is nothing sacred about them in the face of constantly rising rail freight rate structures. The net effect, in any event, is to reduce the favorable position of 2 mill Pacific Northwest power for electroprocess industry establishment—at least in the immediate future.

### Potential Power Sources in the East, South, and Mountain Areas

Table 2 shows the great requirements for electric power to satisfy the rapidly increasing growth of electroprocessing in the United States. The data employed, it must be reemphasized, understate the actual total requirements, as these have been calcu-

lated for only a portion of the electroprocess industry. However, even these partial requirements will present very real problems to the industry. Where shall it go for the types of power supplies which are essential to economic operations?

### NATURAL GAS

With regard to natural gas in the United States, it appears clear that this source of fuel for electric power generation cannot be regarded as an important potential. This is owing to a number of reasons: the value of the gas for higher priced usages will seriously limit its availability for low priced usage such as power production. Furthermore, uses of the gas for purposes other than power production are increasing very rapidly. Finally, supply and reserves are by no means unlimited.

### COAL

With regard to coal in the eastern regions, there appear to be some limitations also for substantial use in the kind of steam-electric generation which will be attractive to electroprocess industries. These limitations cannot be completely defined as yet, but they relate to a number of interrelated factors.

**First, in order to provide large blocks of continuous and reliable power for electroprocess industries, the requisite steam-electric plants must be very large—on the order of two or three hundred thousand kilowatts each. This is owing to the fact that large plants can be designed for very high fuel and generating efficiencies (high pressure, high temperature operations) and at low unit costs of construction and operation. As a consequence of large steam plant size, the reserves of coal available for long-term operations must be very great. Inasmuch as the price of coal to the plant's combustion chamber represents a major portion of the price of generated power, the steam-electric plant should be located at or very near the mine-mouth or at the coal pit. The less the coal is handled and transported, the less its price at the combustion chamber. Furthermore, cooling water requirements for the steam plant are very great so that its location must reflect this consideration also. Immediate access to water transportation is highly desirable in terms of its competitive effect on freight rates. Finally, the steam-electric plant should also be located adjacent to suitable industrial sites for the establishment of plants which will obtain their power supply essentially at steam-electric plant bus bar to minimize transmission costs.**

A cursory examination of the eastern and southern coal region will indicate, at least in principle, that the number of locations where the above-stated requirements can be met are limited. It appears to the authors that perhaps seven or eight locations for large steam-electric plants and associated features may be the maximum feasible for full scale development for the next few years. It is interesting to observe—based on this very tentative estimate—that the total electrical generating capacity of these seven or eight locations may just be barely enough to meet the power requirements of the aluminum industry alone in forecast expansion for the next ten years. Of course, there are other important coal properties which might provide additional reserves at relatively low delivered costs if barge or rail transportation is utilized, but the resulting power prices may not be within economic limits for profitable electroprocess operations.

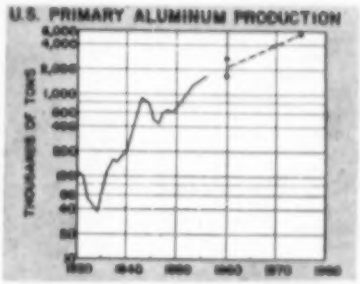
In the west, there are the truly enormous reserves of low-ranking coals in the Dakotas and Rocky Mountain region (*2*). These coals, although of lower fuel value than those in the east and south, are susceptible to large-scale mechanized mining, both stripping and underground. One large electroprocess operation, that of the Aluminum Company of America at Milam, Texas, employs power generated in a very large steam-electric plant of the Texas Light and Power Company utilizing lignite coal. Other similar operations are in various phases of investigation by other major electroprocess industries, an example of which is Reynolds Metals Company in Wyoming.

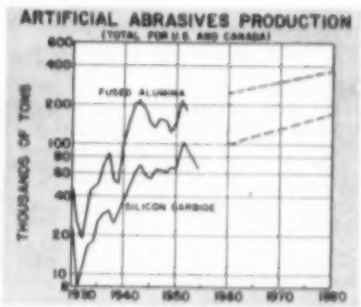
There is not much doubt that this vast coal area will come into its own eventually. There are a number of problems, however, which also tend to limit development for the immediate and relatively long-range future. Briefly stated, these involve scarcity of water supplies large enough to provide necessary cooling media for the steam-electric plants, and the usual problem of freight rates on raw materials and finished electroproducts. At the moment, one might summarize this potential by stating that possible power prices would range somewhere above Pacific Northwest levels and below those of eastern and southern coal potentials. Freight rates would be substantially greater than those applicable to electroprocess operations in the east and southern regions, and perhaps somewhat less than those affecting Pacific Northwest operations.

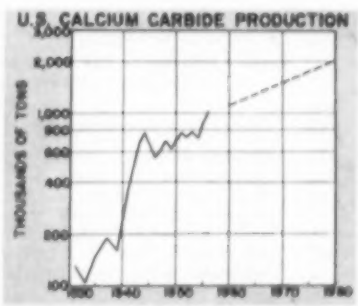
### ATOMIC ENERGY

Regarding the potential utilization of atomic energy for power production, the outlook today is not sufficiently clear as to economics to warrant a realistic opinion. The consensus of technicians involved in developmental activities in this field would lead one to conclude, at least tentatively, that this field of energy production is yet





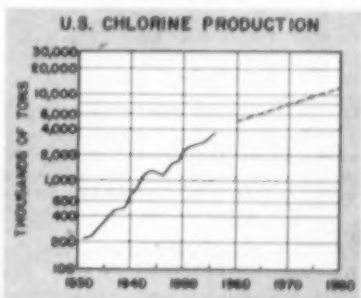



**Table 5.—Pacific Northwest Existing Power Generating Capacity (3)**

(Name plate rating in thous. kw.)

| | 1940 | 1950 | 1956 |
|---|---|---|---|
| Federal agencies: | | | |
| Hydro | 161.74 | 2,181.74 | 4,255.76 |
| Thermal | 18.00 | 18.00 | 18.00 |
| Total | 179.74 | 2,199.74 | 4,273.76 |
| Public agencies: | | | |
| Hydro | 361.55 | 476.85 | 1,156.21 |
| Thermal | 119.66 | 144.66 | 187.95 |
| Total | 481.21 | 621.51 | 1,344.16 |
| Private agencies: | | | |
| Hydro | 1,294.14 | 1,603.40 | 2,079.56 |
| Thermal | 322.84 | 376.44 | 684.25 |
| Total | 1,616.98 | 1,970.84 | 2,763.81 |
| Pacific Northwest totals: | | | |
| Hydro | 1,817.43 | 4,261.99 | 7,491.53 |
| Thermal | 460.50 | 530.10 | 890.20 |
| Grand total | 2,277.93 | 4,792.09 | 8,381.73 |

**Table 6.—Projected Pacific Northwest Hydroelectric Power Projects—Summary**

(Under various stages of consideration)

| | Thous. kw. |
|---|---|
| Authorized | |
| Not under construction | 2,607 |
| Under construction | 102 |
| Total | 2,709 |
| License Granted | |
| Under construction | 3,005 |
| Scheduled | 1,396 |
| Total | 4,401 |
| Permit granted or license requested | 3,553 |
| Total of above | 10,663 |
| Projects under 10,000 kw. | 20 |
| Grand total | 10,683 |

distant as a solution to the electroprocess industry's problem of low-cost power supplies.

### Potential Sources of Power in the Pacific Northwest and Alaska

Table 5 summarizes the progress of power generating installations in the Pacific Northwest region (Washington, Oregon, Western Montana, Idaho). In 1956, about 11% of total name plate capacity was in thermal plants, with the remainder in hydroelectric plants. Over half of the total generating capacity was in Federal multiple-purpose hydroelectric projects.

**Since 1940, the total name plate capacity of power generating plants in the region has almost quadrupled. In spite of this truly phenomenal growth, the margin between total power demands and total plant capabilities has become dangerously narrow. The reasons for this situation have been complex and reflect political and ideological conflicts locally and nationally as to "by whom and how" the vast hydroelectric potential of the region should be developed.**

The immediate outlook for electroprocess industry expansion and establishment in the Pacific Northwest must be realistically described as limited. There will be occasional opportunities based on individual situations where some new hydroelectric power plant systems within the region may desire to obtain some heavy baseload contracts to facilitate financing of project construction. There may be other instances where electroprocess industries may find it possible to negotiate arrangements for obtaining a portion of the output of new generating plants. There is still some possibility of a revision of power sales policies, especially on the Federal regional network, which may face up to the fact that basic industrial development is a "must" to stabilize and diversify the economy of the Pacific Northwest. The latter possibility is in process of active development.

Actually, there is much activity on all drainage basins in the Pacific Northwest regarding new hydroelectric power plants. Table 6 presents a summary list of projects in various stages of consideration, including those under construction. In terms of projects under construction either by the Federal government or non-Federal utilities (both private and public), the scheduled amount of new generation is such that it may barely match growing requirements. Under present policies and sales conditions no power is available for either large scale expansion or the addition of new heavy industrial loads.

There is a growing realization that the only solution to providing power supplies to electroprocess industries—so urgently needed by the region to provide a base for the diversification and stabilization of its economy—lies in a revitalizing of earlier power development concepts in the region. As seen from Table 6, there is a substantial backlog of projects to be constructed from which some portion should be available for electroprocess industry expansion and establishment. The map (Figure 1) shows major existing and potential projects. An acceleration of project timing is there-

**Table 7.—Tentative List of Hydroelectric Power Potentials in Alaska [1]**

(Summary of plants with more than 5,000 kw. potential)

| Map Index | Sub-area and plant designation | Estimated installed capacity—megawatts |
|---|---|---|
| A. | Ketchikan Area—S.E. Alaska | 133-145 |
| B. | Wrangell Area—S.E. Alaska | 211-222 |
| C. | Sitka Area—S.E. Alaska | 57-62 |
| D. | Angoon Area—S.E. Alaska | 37 |
| E. | Juneau Area—S.E. Alaska | 1,775-1,826 |
| F. | Gulf of Alaska Area | 1,968-2,227 |
| G. | Matanuska Valley—Cook Inlet | 207-284 |
| H. | Susitna Basin—Cook Inlet [2] | 1,402-1,420 |
| I. | Kenai Peninsula | 171-196 |
| J. | Bristol Bay Area, Alaska Peninsula, Kodiak Island, and the Aleutians [3] | 531 |
| K. | Kuskokwim Basin | 800 |
| L. | Upper Yukon River Area | 3,350 |
| M. | Middle & Lower Yukon River | 5,450 |
| N. | Tanana River Basin | 321-335 |
| O. | Seward Peninsula [4] | 35 |
| P. | Arctic Region [4] | 225 |
| | Grand total—Alaska | 15,673-16,145 |

[1] Source: U. S. Corps of Engineers; U. S. Bureau of Reclamation; U. S. Federal Power Commission; Central Alaska Power Association, Inc.; private files of North Pacific Consultants.

[2] Includes Chakachatna and Beluga rivers, which are not actually in Susitna Basin, but drain into Cook Inlet. Grouped here for convenience only.

[3] Some revised and expanded estimates place total for this area at 330,000 kw. of "prime power."

[4] Some revised estimates place total "prime power" possibilities in Seward Peninsula and Arctic Region at 350,000-370,000 kw.

fore urgently needed, and is not beyond possibility.

Considerable attention is now being given to the possibilities of large thermal-electric generation from Washington coals. Preliminary analyses indicate excellent possibilities for relieving some of the immediate pressures, especially in terms of "firming-up" so-called interruptible power supplies.

### ALASKA

The vast area of Alaska has long been known to have enormous hydroelectric potential. Interest has been intermittent in such projects as those calling for diversion of the headwaters of the Yukon in Canada to the panhandle of Southeastern Alaska. Similarly, some very preliminary investigations have been made of the Copper River, draining into Prince William Sound. Recent estimates (*4*) place the total hydropotential of Alaska in excess of 16 million kilowatts. The map (Figure 2) shows major hydroelectric regions of the area, and Table 7 lists estimated capacities for each region.

The potential of Alaska is difficult to define in realistic terms at this time with the exception of a few major projects. In the so-called Panhandle of Southeastern Alaska, the major impediment to development is international in nature. The large 1½ million kilowatt Taiya project, for example, will remain untapped until both the United States and Canada find some equitable way of handling the problem of international waters. The same is true of the alternative plan for diversion of the upper Yukon tributaries known as the Taku project. The Copper River, truly one of the great potential power streams of the North American continent, has only been reconnoitered. However, the Wood Canyon projects on the Copper River would have a potential development of over 1½ million kilowatts of what appears to be low-cost power. There seems to be a good possibility that its fishery problem could be resolved satisfactorily.

The other very large projects which would be of interest are in the Yukon and Kuskokwim basins. The Rampart project on the Yukon, northwest of Fairbanks, is estimated to have a potential of over 3 million kilowatts. These tremendous projects are at present isolated from reliable transportation. However, it is not beyond reason to visualize an extension of the Alaska Railroad and the construction of a long-planned Trans-Alaska-Canada railroad (heading northward from the existing system of the Pacific Great Eastern Railroad in British Columbia) which would favorably affect access to these projects for electroprocess industry establishment.

There are numerous smaller potential hydroelectric projects with access to tidewater in Southeastern Alaska, on Prince William Sound, and on the Kenai Peninsula which are of interest for the utilization of local minerals by electroprocessing. Active planning for constructing and interconnecting some power projects is under way in the Kenai Peninsula by the Central Alaska Power Association with headquarters in Anchorage. The same organization has engaged in some preliminary appraisals of a huge regional high voltage and high capacity network for the eventual interconnection of the major hydroelectric projects in Central Alaska.

In all cases of Alaska hydroelectric projects, there is great need for basic investigation -- stream gaging and other related hydrologic and meteorologic measurements; appraisal of geologic conditions at dam sites, and the like. Up to this point, with the exception of some Kenai Peninsula and southeastern Alaska power sites, estimates of power costs are very vague.

### Conclusion

The irresistible pressures throughout the United States for power supplies to meet domestic, commercial, and small industrial demands will continue to press electroprocess industries into more remote areas where industrial and economic activity is not yet fully developed. Much will depend upon a conscious realization by public and private officials responsible for the full development of the Nation's energy resources that the orderly development of electroprocess industries is of paramount importance to defense and economic well-being. In this, the management of electroprocess industries must state their case effectively and continuously. In addition, management must actively seek or develop new power sites, especially in Alaska. There are no alternatives for the expansion of the industry.

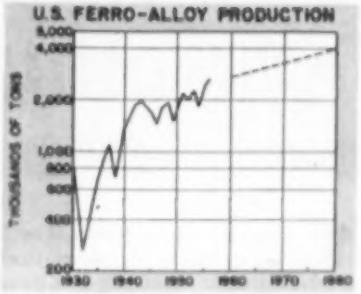
### Literature Cited

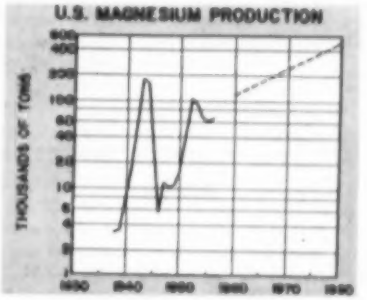

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2. Arthur D. Little, Inc., "Reports to Resources Research Committee of North Dakota," St. Paul, Minnesota (1955).
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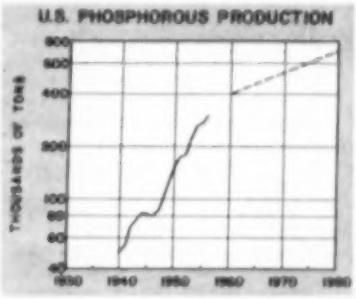

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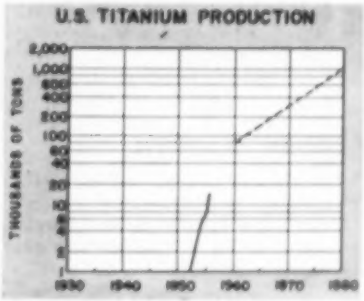
*Presented at A.I.Ch.E. meeting, Seattle, Washington.*





# large-scale continuous production of AMMONIUM PERCHLORATE

**Military requirements and development work by the rocket industry looking toward a smokeless propellent with improved performance have led to greatly increased demand for ammonium perchlorate. This article describes an existing large-scale modern plant for its production, including details of the process, instrumentation, and operating variables. Preliminary experimental work on solubility, safety considerations, and materials of construction is also discussed.**

*Joseph C. Schumacher and David R. Stern* | American Potash & Chemical Corporation, Los Angeles 54, California

With the advent of World War II, military interest in rocket power revived and attention was focused on new types of solid propellants These solid propellants are referred to as double-base and composite propellants. Potassium perchlorate was utilized as a solid oxidizer in composite propellants. This oxidizer created a smoke problem, thus disclosing launching sites and presenting a serious problem for jet-assisted take-off (JATO) from aircraft carriers.

Development work by the rocket industry indicated that by substituting ammonium for potassium perchlorate the smoke problem could be eliminated with improved performance. Improved performance with ammonium perchlorate resulted from the generation of a greater volume of gas and from the lower average molecular weight of the exhaust products.

The propellant industry required material. Western Electrochemical Company started production of ammonium perchlorate on a very limited scale in 1943. Vick Chemical Company built a plant in 1943 at Greensboro, North Carolina, and Electric Reduction Company of Canada was in production during World War II. In 1948, Western Electrochemical Company built a pilot plant at Henderson, Nevada.

The large-scale production of a highly purified product of uniform particle size to give predictable and controllable burning characteristics was essential to the continued development of composite propellants; this was the problem presented to the perchlorate industry. Therefore, development work had to proceed simultaneously with production even though the methods of manufacture left much to be desired. Chemical engineering studies indicated the need for new information.

In April, 1951, Western Electrochemical Company, acting as prime contractor for the Government, initiated a program leading to the design and construction of an ammonium perchlorate plant with a capacity many times greater than any previous plant. Some descriptive material was presented on this installation in 1955 (*1*). This article deals with some of the more technical aspects of designing a large-scale plant for the production of ammonium perchlorate.

## HISTORY

The steady increase in the consumption of ammonium perchlorate in rockets is indicative of its advantages as a solid oxidizer in composite propellants. Ammonium perchlorate has been used as a solid oxidizer in explosives since 1895, when Oscar Carlson (*9*) combined ammonium perchlorate with organics to make explosives. He was granted a British patent in 1897 (*4*). It was the potential use of ammonium perchlorate as an explosive that focused attention upon this compound. Numerous use patents have been filed since this early date.

Carlson reported the manufacture of ammonium perchlorate at Mansboe as early as 1895, and production was officially reported in Germany in 1901 (*9*). A number of inventors (*2, 3, 5, 6, 12*), have secured patents on the manufacture of this compound and their patents deal with the reactions of ammonium chloride, ammonium sulfate, and ammonium nitrate with sodium perchlorate.

In 1956, Schumacher (*13*) was granted a patent for the continuous production of ammonium perchlorate by reacting anhydrous ammonia with aqueous hydrochloric acid and sodium perchlorate. It is interesting to note that this is the only process patent issued during the 33-year period between 1923-1956.

### Chemistry

The previously cited patents (*2, 3, 5, 6, 12*) all covered the reactions of an ammonium salt with sodium perchlorate and the methods of separating the ammonium perchlorate and sodium salt formed. These salts react readily with sodium perchlorate in solution. Using the chloride as an example, the reaction may be represented stoichiometrically as follows:

$$NaClO_4 + NH_4Cl \rightarrow NH_4ClO_4 + NaCl \quad (1)$$

This was the reaction utilized prior to the contemplated large-scale production in 1951. The choice of this particular salt to contribute the ammonium ion is based on the problem of separating the reaction products. It soon became apparent that ammonium chloride and sodium perchlorate were not available in sufficient quantity; new capacity would have to be built to supply these raw materials. The supply of sodium perchlorate was assured through the expansion of the sodium chlorate-sodium perchlorate electrochemical facilities at Henderson, Nevada. The production of ammonium chloride, *per se*, was eliminated by utilizing the following chemical reaction:

$$NH_3 + HCl + NaClO_4 \rightarrow NH_4ClO_4 + NaCl \quad (2)$$

It is this reaction that is the basis of the present commercial production of ammonium perchlorate (*13*).

### Mutual Solubility

Since relatively pure ammonium perchlorate product was desired, some data on the separation of the reaction products were necessary. The mutual solubility of ammonium perchlorate and sodium chloride was determined. These data are presented in Figure 1.

An examination of Figure 1 indicates that the variation of the solubility of sodium chloride with temperature in this




Fig. 2. Effect of moisture on sensitivity and brisance.

system is somewhat less than that of the salt by itself and varies only slightly with temperature. The solubility of ammonium perchlorate, of course, is temperature dependent. Therefore, a crop of ammonium perchlorate crystals can be obtained by cooling. After these crystals are removed, the mother liquor can be evaporated at an elevated temperature and a stoichiometric amount of sodium chloride crystallized. Evaporation of the mother liquor to remove sodium chloride increases the concentration of ammonium perchlorate in the mother liquor. This concentrated liquor can be recycled to complete the continuous reaction and crystallization process.

### Safety

A re-evaluation of the hazards involved in the manufacture, storage, and transportation of ammonium perchlorate was a necessary part of the design of this large production unit. It was known that ammonium perchlorate presented a fire and explosive hazard and was susceptible to ignition or detonation by impact or by thermal shock (*8*), but an examination of the literature indicated that not all investigators were in agreement as to the properties of ammonium perchlorate. Consequently, a limited amount of experimental work was performed on the sensitivity, thermal decomposition, and impact sensitivity.

"Minimum primer sensitive" tests were conducted utilizing an apparatus described by Cook and Talbot (*7*) which they used to determine the sensitivity of ammonium nitrate-hydrocarbon mixtures. A similar test, known as the "Small Lead Cylinder Test," is used by the U. S. Bureau of Mines (*8*).

A solid lead cylinder 1½ in. in diam. and 3 in. high was supported on a rigid steel support. A steel plate 3 in. × 3 in. × ½ in. was centered on top of the lead cylinder. A cylindrical cardboard cartridge, 1½ in. in diam. and 4 in. high, filled loosely with ammonium perchlorate and containing electric detonators of various strengths, was placed on the ½ in. steel plate and detonated. The brisance effect was indicated by the degree to which the lead cylinder was depressed. The sensitivity was determined by the size of the detonator required to initiate an explosion.

The effect of increasing moisture content on sensitivity is presented in Table 1 and visually in Figure 2. Cylinder No. 32 is the standard. Cylinder No. 4 illustrates the effect produced when the equivalent of 10 grams of mercury fulminate is detonated in potassium chloride. Cylinders 6, 7, and 13 represent depression when detonating ammonium perchlorate containing 0.02, 1.0, and 6.0 wt. per cent moisture, respectively. Cylinders No. 7, 8, 12, and 13 indicate no significant depression when compared to the standard detonator and the dry material.

These detonation experiments, along with the thermal decomposition and impact sensitivity tests, led to formation of the following guiding principles:

1. The impact sensitivity of high purity ammonium perchlorate is comparable to that of most high explosives.
2. Metallic contamination increases the sensitivity of ammonium perchlorate (i.e., certain metallic perchlorates are extremely sensitive).
3. Ammonium perchlorate is thermally stable below 150° C.
4. Contact of organic material with ammonium perchlorate constitutes a fire and explosive hazard.
5. The handling of solutions and wet solid ammonium perchlorate is not hazardous, but the drying processes present predominantly a fire, and possibly an explosive, hazard.

These principles were incorporated into the design of the plant. The handling and drying of the solid product were placed in two isolated units with duplicate equipment. The drying buildings contained a complete automatic deluge system and were separated according to specified quantity-distance tables.

Previous experience during pilot plant operations had indicated the type of packing and lubrication that would give safe operation. Wet dust collection systems and the selection of equipment that would give a minimum of dusting were added safety features incorporated into the design.

Considerable research was done on the effect of feed stream impurities on the safety of the reaction.

### Materials of Construction

Simultaneously with the researches on mutual solubility and safety, a corrosion testing program was initiated. The results of a number of total immersion tests are given in Table 2. On the basis of these tests and experience, the materials of construction were chosen. All welded piping and medium size vessels were to be 347 stainless. When delivery of large equipment was a problem because of the 347 stainless, a compromise was made on heat-treated 316 stainless. The sections of the plant that would be in contact with excess hydrochloric acid were constructed of glass lined steel or Hastelloy C.

### Process Flow

A simplified flow diagram of the plant is presented in Figure 3. The process is characterized by four steps:

1. Reaction of ammonia, hydrochloric acid, and sodium perchlorate.
2. Fractional crystallization of ammonium perchlorate.
3. Centrifugation of the ammonium perchlorate.
4. Fractional crystallization of by-product sodium chloride.
5. Drying, blending, and packaging of ammonium perchlorate.

Substantially all water entering the system must be removed from the sodium chloride crystallizer; however, sufficient water must be present originally in the ammonium perchlorate crystallizer to prevent the crystallization of any sodium chloride. There must be good control over the water entering the system; this is accomplished at the heart of the process, namely, the reactor system.

**Table 2.—Corrosion Rates (80° C.)**

| Metal sample | Corrosion rate (80° C.) (mils./yr.) |
|---|---|
| Titanium | 0 |
| Durimet 20 | 0 |
| Hastelloy HB-1 | 0 |
| Hastelloy HC-3 | 0 |
| 347 | 0.0856 |
| Hastelloy C | 0.130 |
| 321 | 0.168 |
| 316 | 0.242 |
| 302 | 0.312 |
| 430 | 0.467 |
| Durriron | 0.565 |
| Inconel | 0.690 |
| Nickel | 1.38 |
| Monel | 2.96 |
| Lead (unknown composition) | 3.45 |
| Lead (6% antimonial) | 3.46 |
| Lead (8% chemical lead) | 3.98 |
| Mild steel (tank type) | 4.02 |
| Hastelloy B | 5.14 |
| Copper | 8.06* |
| Cast iron | 65.0 |
| Aluminum | 262.0 |

* Rate at 60° C. in saturated $NH_4ClO_4$—NaCl solution.

## REACTOR SYSTEM

The reactor system consists of two stages operated continuously and controlled automatically. The first stage consists of a 1,000-gal. glass lined reactor while the second stage consists of a 750-gal. glass lined reactor. This reactor system contained a large part of the instrumentation in the plant. A simplified instrumentation diagram is presented in Figure 4.

All feed streams are ratio controlled. The discharge from the first stage reactor is continuously monitored for $pH$. The $pH$ controller on this stream resets the controller on the hydrochloric acid stream; this it can do only within narrow limits, since this controller is on ratio control. The discharge from the second stage reactor is also on $pH$ control with a secondary ammonia stream being fed into this vessel. If the $pH$ drops too low, all the feed streams to the reactor are stopped, the feed to the crystallizer is stopped, and the reactor charge is automatically recycled until the $pH$ is corrected manually or automatically. The temperature of the reactors is controlled at 90° C. by mixing steam and water in the vessel-jackets. All controllers have high and low alarms which are audible and visible. The instruments are grouped into a console control panel and the whole reaction system, along with the crystallizers, is under "push button" control at this point.

**Table 1.—Effect of Moisture on Sensitivity and Brisance**

| Lead cylinder no. | Charge | Cap. no. & quantity | Moisture wt. % | Measurement of lead cylinder-in. Before firing | After firing |
|---|---|---|---|---|---|
| 4 | KCl | 1—XC-32 [d] | ... | $3\frac{1}{32}$ | $2\frac{31}{32}$ |
| 5 | $NH_4ClO_4$ [a] | 1—XC-32 [d] | 0.02 | 3 | $2\frac{27}{32}$ |
| 6 | $NH_4ClO_4$ | 1—XC-32 [d] | 0.02 | 3 | $2\frac{27}{32}$ |
| 7 | $NH_4ClO_4$ [b] | 1—XC-32 [d] | 1.0 | 3 | $2\frac{27}{32}$ |
| 8 | $NH_4ClO_4$ | 1—XC-32 [d] | 1.0 | $2\frac{31}{32}$ | $2\frac{29}{32}$ |
| 11 | $NH_4ClO_4$ | 1—No. 8 [e] | 1.0 | 3 | 3 |
| 12 | $NH_4ClO_4$ [c] | 1—No. 8 | 6.0 | 3 | 3 |
| 13 | $NH_4ClO_4$ | 1—XC-32 | 6.0 | 3 | $2\frac{30}{32}$ |

[a] Final dried product.
[b] Prior to drying.
[c] First centrifuging of crystals.
[d] Equivalent to 10 grams of mercury fulminate.
[e] Equivalent to 2 grams of mercury fulminate.

**Table 4.—Typical Product Analyses**

| Component | Typical product specification (wt. %) | Typical lots (Per cent retained) 1 | 2 | 3 |
|---|---|---|---|---|
| Water insol. | .10 max. | .002 | .002 | .003 |
| Ash | .25 max. | .040 | .060 | .070 |
| Chlorates ($NaClO_3$) | .15 max. | .002 | .002 | .003 |
| Chlorides ($NH_4Cl$) | .20 max. | .014 | .021 | .024 |
| Sulfates $(NH_4)_2SO_4$ | .20 max. | trace | trace | trace |
| Bromates ($NaBrO_3$) | .04 max. | .001 | .001 | .002 |
| Non-alkali metals | .04 max. | .002 | .003 | .002 |
| Moisture | .02 max. | .009 | .007 | .007 |
| Reaction to M.O. | neutral | neutral | neutral | neutral |
| $NH_4ClO_4$ assay | 99 min. | 99.9 | 99.9 | 99.9 |

## AMMONIUM PERCHLORATE CRYSTALLIZER

Since the reactor system is a constant volume system, the feed rate to the ammonium perchlorate crystallizer is constant. This stainless steel crystallizer is operated continuously, cooling the reactor effluent from 90° C. to 35° C. by vacuum evaporative cooling. The feed liquor is mixed continuously with a large amount of circulating mother liquor and the resulting mixture is passed into a vaporizer, where the solution supersaturates. The solution then flows upward through a dense bed of crystals, relieving its supersaturation on the crystal suspension. A slurry containing the desired size distribution is removed continuously.

## AMMONIUM PERCHLORATE CENTRIFUGATION

The slurry is fed to a centrifuge where mother liquor is removed continuously and the crystals are washed. The washed crystals are discharged directly into a tank of saturated ammonium perchlorate solution. This saturated solution serves to reduce the chloride concentration of the solids and as a transfer medium for the ammonium perchlorate to the drying operation located some distance away. The wash water, mother liquor, and crystallizer overflow are collected together and pumped to the sodium chloride crystallizer.

## SODIUM CHLORIDE CRYSTALLIZER

Concentration of the mother liquor, which is depleted in ammonium perchlorate, is accomplished in a vacuum evaporator with an external heat exchanger. This crystallizer works on

**Table 3.—Effect of Operating Temperature of Sodium Chloride Crystallizer**

| Temp. NaCl crystallizer (° C.) | 80 | | | | 60 | | | 50 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp. $NH_4ClO_4$ crystallizer (° C.) | 25 | 30 | 35 | 50 | 25 | 30 | 35 | 50 | 25 | 30 | 35 |
| Recycle (tons/ton $NH_4ClO_4$) | 1.60 | 1.94 | 2.43 | 4.19 | 2.74 | 3.59 | 5.04 | 15.2 | 4.64 | 6.94 | 12.9 |
| Water evaporated * (tons/ton $NH_4ClO_4$) | 1.50 | 1.51 | 1.52 | 1.56 | 1.53 | 1.55 | 1.59 | 1.79 | 1.56 | 1.61 | 1.74 |

* Quantity of water evaporated from salt crystallizer only.

the same principle as the ammonium perchlorate crystallizer; however, no attention is paid to particle size other than to secure a particle size that will centrifuge and wash easily. The sodium chloride slurry from the crystallizer is also fed continuously to a centrifuge.

### SODIUM CHLORIDE CENTRIFUGE

The solids discharged from this centrifuge can be recovered as a solid or dissolved and pumped to waste. At present the solids are dissolved. The wash water and mother liquor from the centrifuge are mixed in a surge tank with the crystallizer overflow. The solution from this surge tank is rich in perchlorate and consequently is pumped to the reactor system as recycle. Loss of mother liquor with the sodium chloride solids discharged at this point can lower the over-all chemical efficiency. The washed sodium chloride discharged from the continuous centrifuge averages better than 99.0 per cent pure.

### Operating Variables

Since a recycle stream rich in chloride has been added, a certain water content or balance must be maintained to prevent any sodium chloride from separating out in the ammonium perchlorate crystallization. The quantity of water necessary is a function of the temperature of operation of the crystallizers, the mutual solubilities of the salts, the amount of water entering the whole plant cycle, and the composition and quantity of the recycle stream.

### TEMPERATURE LEVELS OF OPERATION

Since all of the water entering the system must be evaporated, it is desirable to keep water additions to a minimum. If the crystallizer were cooled to a low temperature, the quantity of recycle saturated with chloride would be low; however, it would be necessary to add larger quantities of water to prevent crystallization of sodium chloride, since the solubility of the sodium chloride decreases slightly with temperature. Allowing the tempera-

**Table 5.—Typical Size Distribution**

| Tyler screen size | Typical lots (Per cent retained) 1 | 2 | 3 |
|---|---|---|---|
| −20 | 100 | 100 | 100 |
| −48 | 93.6 | 92.6 | 91.5 |
| −100 | 30.0 | 23.4 | 26.9 |
| −150 | 9.2 | 6.3 | 8.6 |
| −325 | 0.6 | 0.5 | 0.8 |

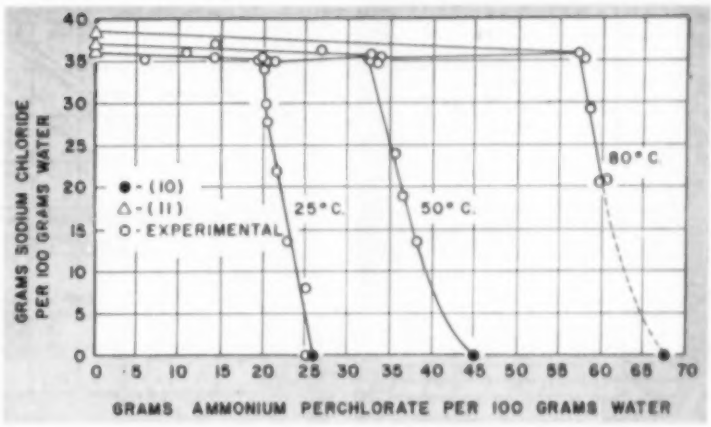



Fig. 1. Mutual solubility.

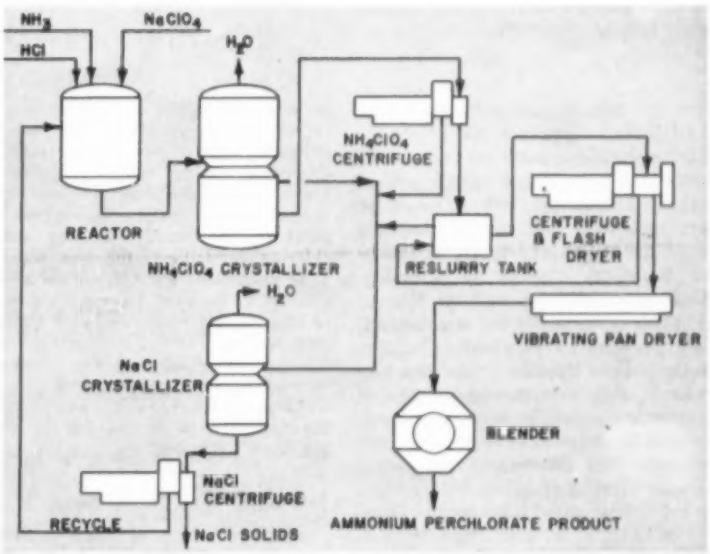



Fig. 3. Simplified process flow diagram.

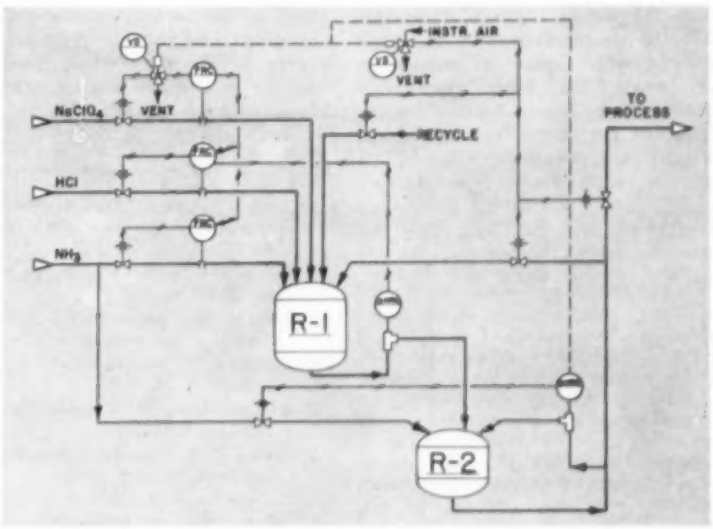



Fig. 4. Reactor instrumentation.

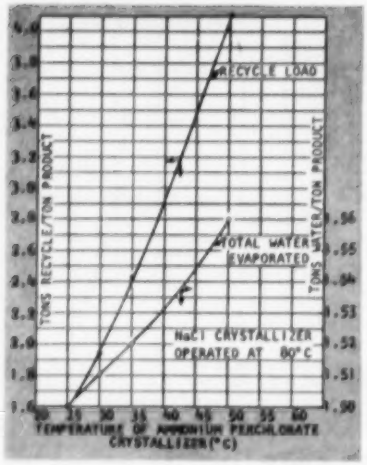



Fig. 5. Effect of ammonium perchlorate crystallizer temperature on recycle and evaporation loads.

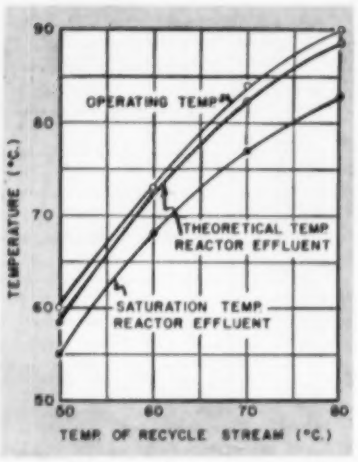



Fig. 6. Effect of sodium chloride crystallizer temperature on reactor thermodynamics.

ture of the ammonium perchlorate crystallizer to approach that of the sodium chloride crystallizer would increase the quantity of recycle appreciably. This larger stream would be saturated with sodium chloride and large quantities of water would be necessary to suppress its solubility. These considerations indicate that an optimum temperature for the ammonium perchlorate crystallizer in relation to the sodium chloride crystallizer may exist so that a minimum quantity of evaporation would be necessary. However, calculations indicate that this optimum is a function of the degree of saturation approached with respect to each unsaturated component in each crystallizer. If an exit composition of 34.0 g. NaCl/100 g. of water from the ammonium perchlorate crystallizer is set as a limit, and the exit stream from the sodium chloride crystallizer is to be undersaturated by the same amount with regard to ammonium perchlorate, the water evaporation curve is flat. Figure 5 illustrates the effect of the ammonium perchlorate crystallizer temperature on the recycle and evaporative loads. A temperature of 35° C. was selected for ammonium perchlorate crystallization, since this was the lowest temperature feasible without refrigeration.

Table 3 illustrates the effect of the operating temperature of the sodium chloride crystallizer on the evaporation load and recycle loads. An examination of these data indicates that lowering the temperature of the salt crystallizer is not critical if the perchlorate crystallizer is maintained at a sufficiently low temperature, but that raising the temperature of the perchlorate crystallizer and lowering the temperature of the salt crystallizer simultaneously do increase the evaporation load and can increase the recycle load appreciably. Since the perchlorate crystallizer temperature is limited by cooling water conditions, the lower temperature level is fixed. Table 3 also indicates that the higher the temperature of operation of the sodium chloride crystallizer, the less water is to be evaporated and the less the amount of recycle; however, the corrosive nature of this solution places an upper temperature limitation on this unit operation. The original design was for a temperature of 80° C. Severe corrosion of the 316 heat exchanger on the sodium chloride crystallizer has necessitated the lowering of this temperature.

## REACTOR

Since recycle is returned to the reactor (See Figure 3), the temperature and quantity of this recycle influence the reactor heat balance. The effect of the recycle on the reactor operating conditions is presented in Figure 6. An examination indicates that the exothermic heat of reaction liberated, combined with the recycle stream, maintains the reactor effluent above the saturation temperature.

### Startup

The startup of the plant went smoothly, owing to considerable advance preparation and planning. All instruments were calibrated and put into operation prior to startup. All vessels, pumps, centrifuges, and crystallizers were also tested before startup.

Product was discharged from the ammonium perchlorate centrifuge within three days after startup. This first product did not meet the specifications with regard to particle size, but the operation of the full-scale continuous automatic reactor system was successfully demonstrated. Within several months, operating personnel had turned out product of the desired characteristics for solid propellant fuel.

### Characteristics of Product

Since burning rates and stability are of prime importance to rocket engineers, the product specifications are very rigid with regard to chemical purity and particle size. Tables 4 and 5 present data illustrating the characteristics of the product consistently produced from this plant; these data are typical assays of some lots. Emphasis is placed on the 99.9 per cent purity and the extremely low moisture content. Product has also been made to meet other particle size specifications.

### Acknowledgment

The complete development, design, and construction of this plant represent the combined efforts of a number of individuals. The authors appreciate the contributions made by the operating staff of American Potash & Chemical Corporation, and the permission of the Department of the Navy to publish this article on the installation which is part of the United States Naval Industrial Reserve.

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*Presented at A.I.Ch.E. meeting, Baltimore, Maryland.*

# COMMERCIAL ETHYLENE PRODUCTION BY PROPANE PYROLYSIS IN A MOLTEN LEAD BATH

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**Results of a plant scale research program on commercial ethylene production by propane and propane-propylene pyrolysis in a molten lead bath indicate that:**

- **the molten lead bath is a convenient means for transferring heat at moderately high temperatures;**
- **propane pyrolysis in a lead bath unit yields the same product distribution as propane pyrolysis in a tubular reactor;**
- **heat transfer between molten lead and its agitating gas is quite high;**
- **mechanical problems involved in operating a lead bath unit are not great.**

The key role of ethylene in our petrochemical industry is well recognized. In the past 15 years, United States production of this versatile building-block has increased more than twenty fold, reaching a total of more than three billion pounds in 1956. More productive capacity is planned or under construction, and the future growth of ethylene seems almost unlimited.

Much of this ethylene is produced directly by the thermal decomposition of $C_2$-$C_4$ light hydrocarbons. The pyrolysis, or "cracking," operation is an endothermic reaction, the heat for which may be supplied directly or indirectly from the combustion of hydrocarbon fuels. A common technique is

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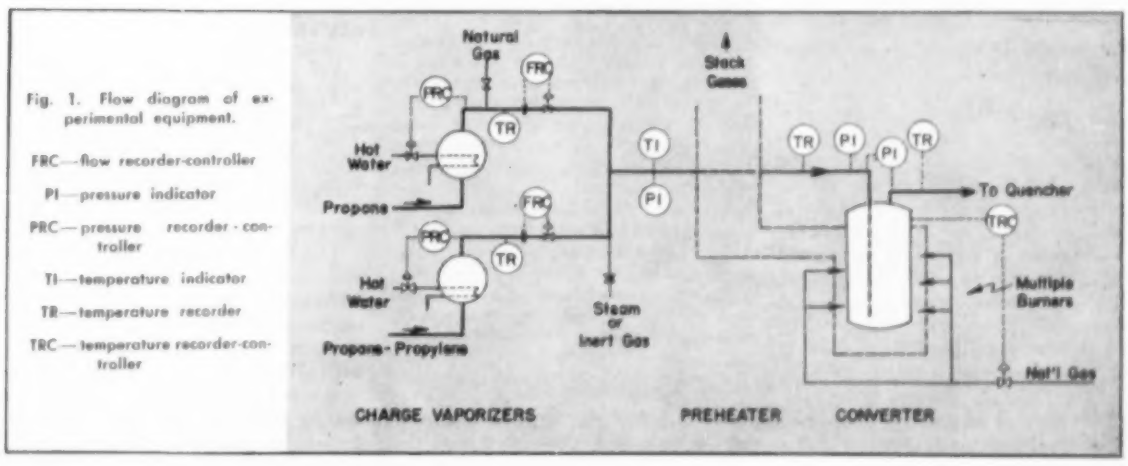



Fig. 1. Flow diagram of experimental equipment.

FRC—flow recorder-controller

PI—pressure indicator

PRC—pressure recorder-controller

TI—temperature indicator

TR—temperature recorder

TRC—temperature recorder-controller

indirect heat transfer through the walls of a fired tubular reactor. Descriptions of apparatus and calculation techniques for this method have been given ample coverage in the literature (*3, 4, 6, 11, 12*).

Commercial pyrolysis devices other than the fired tubular reactor have been described but apparently have not been used commercially. These include the regenerative-type furnace (*5*), the moving pebble bed (*2, 7*), and the partial oxidation reactor (*1*). Improvements in the art of tubular reactor operation appear to have been sufficient to outweigh the unique advantages of these special devices.

An additional commercial technique for light hydrocarbon pyrolysis is the passing of reactant gases through a bath of molten lead. This technique has been used successfully at Monsanto's Texas City plant since late 1944. Results of full scale research conducted prior to regular production are described in this article.

## Experimental Basis

### EQUIPMENT

The experimental equipment represented one of a battery of units actually utilized in subsequent ethylene production. A flow diagram of the equipment is shown in Figure 1. It consisted essentially of a charge system, a preheater, a lead bath converter, and a quencher. Auxiliary equipment, not shown, served such functions as gas sampling, quench water cooling and recirculation, and coke removal.

Charge material, usually propane, was vaporized and metered under carefully controlled conditions. The vapors were then preheated to a controlled temperature and charged to the converter unit where pyrolysis occurred. The effluent gas mixture was quenched directly with water to stop the reaction, and then sampled for analysis. In this flow scheme only the converter (Figure 2) is unusual and worthy of detailed description.

**The converter is a vertical, cylindrical vessel of Type 309 stainless steel, 2 ft. 6 in. O.D. by 5 ft. 7½ in. high. The shell and lower dished head are of ⅝ in. wall thickness. The top cover is cast steel, and is flanged to the shell. Internal fittings, all of Type 309 stainless steel, include a central dip pipe, 4.5 in. O.D. with 0.25 in. wall, splash baffles, and a thermowell. Under nonflow conditions, a level of molten lead is maintained approximately 33 in. above the bottom of the dip pipe.**

**The entire converter is suspended in a cylindrical furnace setting, the steel shell of which is 5 ft. 4 in. I.D. by 7 ft. 8 in. high. The firebrick lining is approximately 11 in. thick, which leaves a 9 in. space between the wall of the converter and the surface of the firebrick, and a 15 in. space between the bottom of the converter and the surface of the firebrick.**

Firing is by means of 12 Surface Combustion N6165 burners, distributed in 4 horizontal rows of three each. The bottom and third rows are rotated 60 deg. relative to the second and fourth rows. The burners are directed tangentially to avoid flame impingement on the converter walls.

Firing is controlled automatically by the measured lead temperature. Effective heat transfer area outside the converter is approximately 40 sq. ft. Combustion gases are removed from a tangential exit and are used to preheat the charge stock.

### MATERIALS

Commercial tank car propane was used as a charge material. For most of the experiments described here, this material had the following composition by weight:

| | % |
|---|---|
| ethane | 0.2 |
| propane | 98.8 |
| butanes | 0.6 |
| pentanes | 0.4 |
| | 100.0 |

For five runs, a charge material containing 91.9 wt. per cent propane was used, and for three runs the propane content of the charge was 95.9 wt. per cent. Some runs employed a mixed propane-propylene charge; this material was obtained by blending an available plant stream of mixed $C_3$'s with commercial propane.

Chemical lead was used in the converter. Since the physical properties of lead are of importance in the interpretation of the results of this work, certain of the properties are listed in Table 1 (*9*).

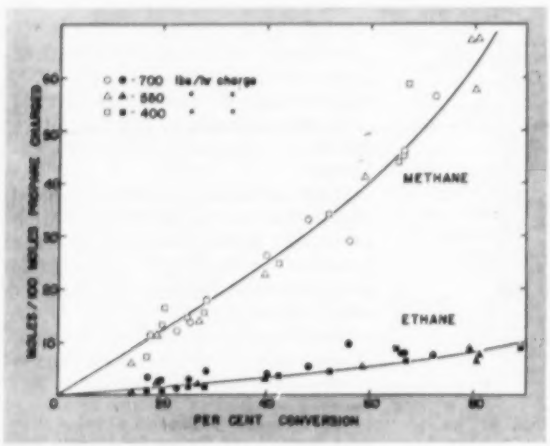



Fig. 3. Once-through yields from propane pyrolysis.

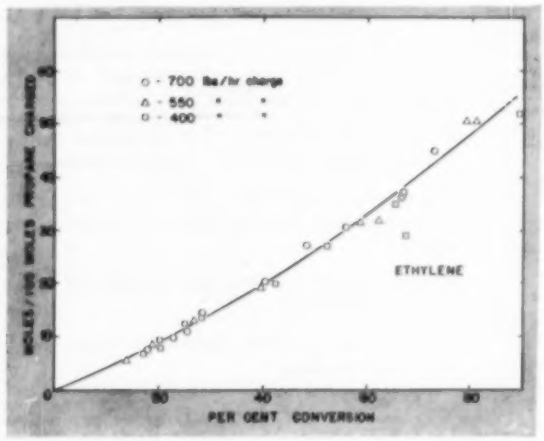



Fig. 4. Once-through yields from propane pyrolysis.

### GAS ANALYSIS

For all runs, charge and effluent component analyses were made by the E. W. Saybolt Company, Houston, Texas. Samples were collected by water displacement and marked in code. Duplicate samples were taken at intervals and worked in with later samples as checks.

The Saybolt analyses were made by low-temperature fractionation (Podbielniak) techniques, with catalytic oxidation of hydrogen in the $H_2$-$CH_4$ fraction and catalytic hydrogenation of $C_2H_6$ in the $C_2$ fraction. It was possible later to confirm these analyses by the mass spectrometer; excellent agreement was obtained.

In the experimental unit, control analyses for ethylene and propylene were run by selective absorption (Burrell) methods. The specific gravity of the converter effluent was also measured in order to check the gravity calculated from the Podbielniak analysis.

#### Experimental Method

Three standard charge rates were used: 400, 550, and 700 lb./hr. The lower limit was set by projected economics and by dangers of coking at long residence times. The upper limit was set by lead carryover in the effluent gases, and represented superficial velocities through the converter as high as 2.5 ft./sec. In the flow range employed, liquid-vapor contact in the converter appeared to be excellent.

The range of conversion was 14-80 per cent net decomposition of charge propane. Since initial reaction distribution was not of great importance in these studies, it was not deemed necessary to study conversions lower than 14 per cent. Previous experience in other pyrolysis operations had indicated that conversions higher than 80 per cent led to secondary reactions causing a decrease in ethylene yield.

Converter lead temperature was the primary control variable for studying yields and conversions. This temperature was varied according to flow rate and desired conversion, and it was found that 1,470-1,500° F. was the maximum practicable lead temperature. This upper limit was set both by vapor pressure losses of lead and, at high flow rates, by firing capacity of the furnace.

Although it was realized that gas temperature, rather than lead temperature, was more appropriate as a control variable, piping and shielding arrangements required for an accurate temperature measurement could not be accommodated in the physical layout. The effective gas temperature was determined to be within approximately 30° F. of the measured lead temperature.

It was possible to control preheat temperature of the converter charge. For most runs this temperature was held at the "point of incipient cracking," as determined by control analyses, or about 1,000° F. Several runs were made at lower preheat temperatures, the effect of which will be shown below.

All of the runs were made at a total reactor pressure of 3.5-4.0 lb./sq.in. gauge.

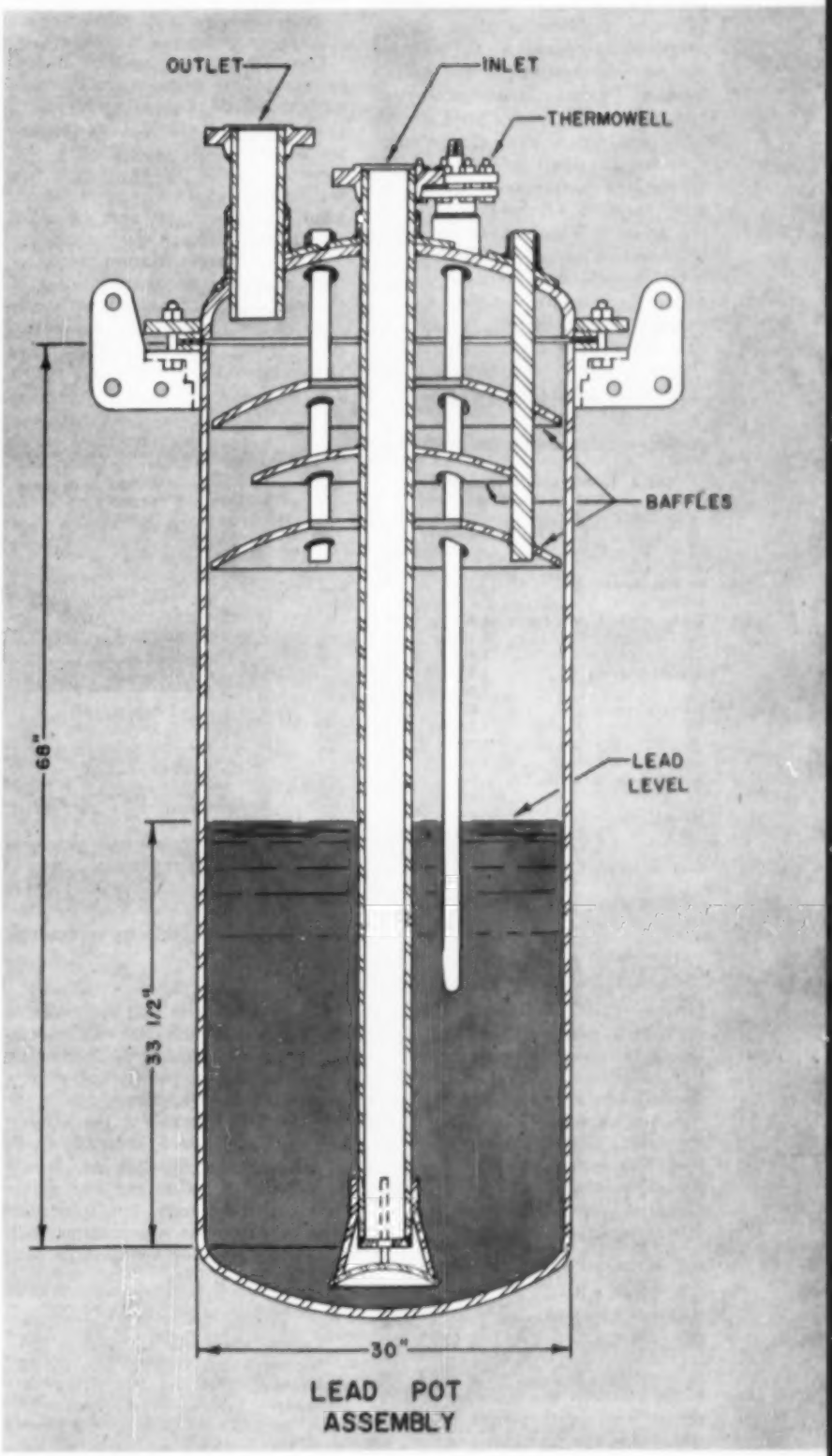



Fig. 2. Cut-away drawing of the lead bath converter.

## Experimental Results

### YIELDS

The effluent gas from the converter contained the following components: hydrogen, methane, ethylene, ethane, propylene, propane, a $C_4$ fraction (butenes and butadiene), and a $C_5$+ fraction. Product distribution was calculated as once-through yield (moles component per mole of charge material) and correlated against conversion (percentage disappearance of key reactant). Plots of these yield values are given in Figures 3-6. It should be noted that throughput rate has little effect on yield, at a given conversion, within the range of conditions studied. In other words, there is a range of time-temperature combinations which may be used to produce a desired yield pattern. This is a point of great importance in that it allows considerable flexibility in reactor design.

Values from Figures 3-6 were converted to ultimate yield values (moles component per mole of charge material converted) and plotted against conversion. Extrapolation to zero conversion made it possible to estimate the course of initial propane decomposition. The primary reactions were indicated as:

| | |
|---|---|
| $C_3H_8 \rightarrow C_2H_4 + CH_4$ | 40% |
| $C_3H_8 \rightarrow C_3H_6 + H_2$ | 36% |
| $C_3H_8 \rightarrow \frac{1}{2} C_2H_6 + CH_4$ | 10% |
| $C_3H_8 \rightarrow \frac{1}{2} C_2H_6 + \frac{1}{2} C_2H_4 + \frac{1}{2} CH_4$ | 14% |

Schneider and Frolich (*10*) estimated that only the first two reactions are primary, and Schutt (*11*) estimated that the first two reactions account for 93.5 per cent of initial propane decomposition. Analytical imprecision in this work may have given too much emphasis to the last two reactions, but it seemed clear that butenes, and probably ethane, were primary decomposition products.

Several runs were made with propane-propylene mixtures, in order to study the effects of propylene recycle in production operations. Once-through yields are shown in Figure 7, for the case of 700 lb./hr. charge rate and 1,460° F. lead temperature (maximum conditions). It will be noted that the once-through yield of ethylene from the charge mixture decreases with increasing propylene content of the feed. Thus, propylene is ordinarily more useful for the direct production of propylene derivatives than as a charge material for ethylene. Another point of interest is that the make of $C_5$+ materials increases with increasing propylene in the feed. This is due to the concurrent polymerization of a portion of the propylene.

The $C_5$+ fraction of the effluent, reported in Figure 6, is largely $C_5$-$C_7$ aromatics and cyclic diolefins. Breakdown analyses were not run at the time of these tests, but subsequent analyses by mass spectrometer indicated the following approximate composition by weight:

| | % |
|---|---|
| Cyclopentadiene | 30 |
| Isoprene | 15 |
| Benzene | 40 |
| Toluene | 15 |
| Total | 100 |

Additional effluent materials were found in the quench system. These were in the form of a sludge which contained naphthenic oils, coke, and lead. The yield of sludge taken over an extended period of operation was quite small—on the order of 1.0 wt. per cent or less of the charge material.

### MOLAR EXPANSION

A point of consideration in kinetics calculations is the expansion of the reaction mixture as it passes through the converter. On the basis of the primary reactions postulated above, the expansion factor $\delta$ (defined as moles expansion per mole converted) is 0.88. Figure 8 shows experimental data as total moles product per mole charge plotted against conversion. The slope of this curve, $\delta$, is shown to be 0.95 in the 0-60 per cent conversion range.

### REACTION KINETICS

A kinetic analysis of converter operation must depend upon whether longitudinal mixing is expected to occur. For a tubular converter, longitudinal mixing is usually absent, and plug flow conditions prevail. For the lead bath unit, however, one would expect the degree of mixing to be very high. One might compare the lead bath converter with a stirred tank or fluidized bed; concentration of gas in the converter at any instant is uniform and equal to the exit concentration.

For the case of the well-mixed reactor, the integrated flow equation may be used:

**Table 1.—Physical Properties of Molten Lead (9)**

| | Temperature, ° F. | Value |
|---|---|---|
| Melting point | 621 | |
| Boiling point | 3,164 | |
| Vapor pressure, mm. Hg | 1,809 | 1.0 |
| | 2,133 | 10.0 |
| | 2,583 | 100.0 |
| Specific gravity | 1,202 | 10.3 |
| | 1,562 | 10.1 |
| Viscosity, cp. | 826 | 2.12 |
| | 1,024 | 1.70 |
| | 1,297 | 1.35 |
| | 1,551 | 1.19 |
| Specific heat, B.t.u./lb. ° F. | 621 | 0.039 |
| | 932 | 0.037 |
| Thermal conductivity, B.t.u./hr. ° F./ft. | 626 | 9.4 |
| | 932 | 9.0 |
| | 1,292 | 8.7 |
| Heat of fusion, B.t.u./lb. | 621 | 10.6 |

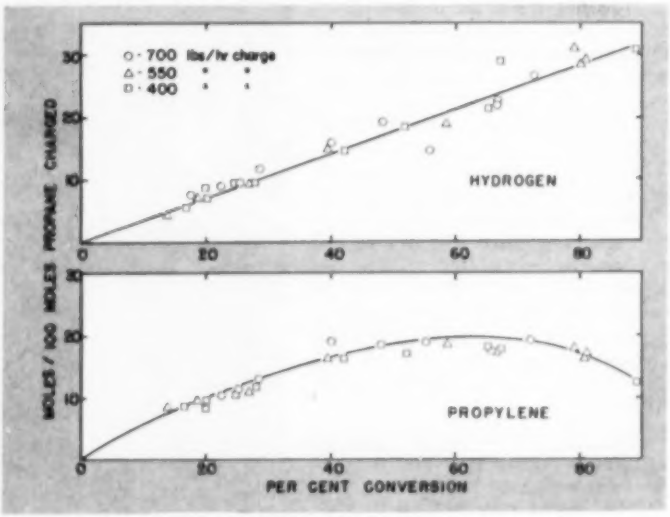



Fig. 5. Once-through yields from propane pyrolysis.

$$\frac{V_R}{F} = \frac{\Delta X_A}{r} \quad (1)$$

In units convenient for this work, reaction rate may also be defined by

$$r = \frac{k\pi(1 - \Delta X_A)}{(1 + \delta\Delta X_A)} \quad (2)$$

This equation is based on first-order decomposition of the charge material. Derivation and discussion are given by Fair and Rase (*3*).

If Equations 1 and 2 are combined,

$$k = \frac{F(\Delta X_A)(1 + \delta\Delta X_A)}{V_R\pi(1 - \Delta X_A)} \quad (3)$$

In this expression, all quantities on the right were measured. The net volume of the converter was 12.5 cu. ft., Values of the reaction velocity constant were calculated and plotted against measured lead temperatures. The results are shown in Figure 9. The effective average gas temperature appears to be within about 30° F. of the lead temperature, based on the literature value for commercial tubular units (*4*).

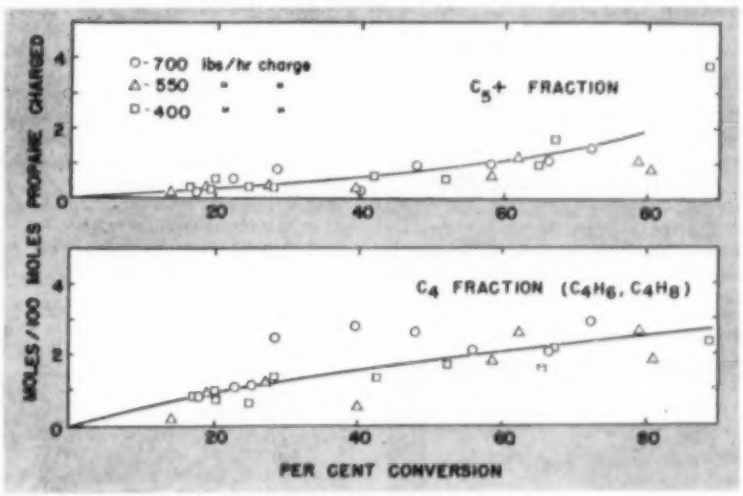



Fig. 6. Once-through yields from propane pyrolysis.

### HEAT TRANSFER

On the basis of kinetics calculations, the effective gas temperature in the converter appeared to be about 30° F. lower than the measured gas temperature. Thus, it would appear that heat transfer between the lead and the gas was quite good, particularly since the charge gas had a temperature of about 1,000° F. and was, at times, heated to 1,400° F. or more in the converter.

Figure 10 shows the relationship between lead temperature and conversion. It should be noted that throughput has a slight, but definite, effect on conversion. This indicates that heat transfer between lead and gas is not a limiting step. Gas temperature follows lead temperature directly, and variation in conversion is a residence time effect only.

Another point of interest in Figure 10 is that three runs are indicated with a low preheat temperature (790-820° F.). No significant effect on conversion, for a given lead temperature, was noted; the transfer of heat from the lead provided the sensible heat quite rapidly.

No attempt was made to measure heat transfer coefficients between the converter wall and the gas-lead mass. The temperature of the outside wall of the converter was estimated by means of an optical pyrometer, and on this basis inside coefficients (based on calculated heat flux, corrected inside wall temperature, and lead temperature) were on the order of 150-250 B.t.u./(hr.)(sq.ft.)(°F.). These values are consistent with those reported for fluidized beds under the best conditions for heat transfer.

### MECHANICAL OPERATION

The low heated surface : volume ratio for the lead bath unit appeared favorable from a standpoint of coke formation. The experimental unit was operated continuously for 1½ months and then opened for inspection. Only a thin scale of coke was noted on the cover of the converter, and no coke was found on the walls. The major

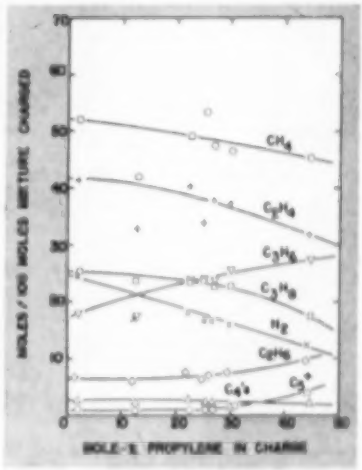



Fig. 7. Yields from propane-propylene pyrolysis (700 lb./hr. total charge; 1,460° F. lead temperature).

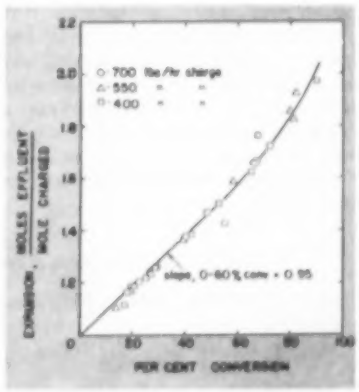



Fig. 8. Molar expansion during propane pyrolysis.

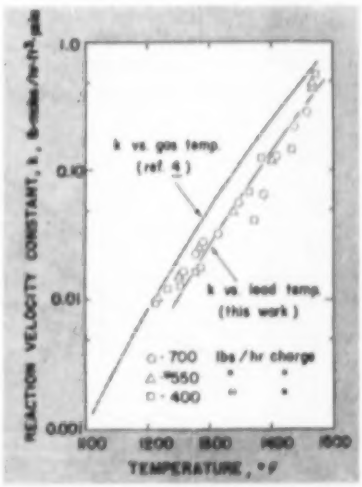



Fig. 9. Reaction velocity constants for propane pyrolysis.

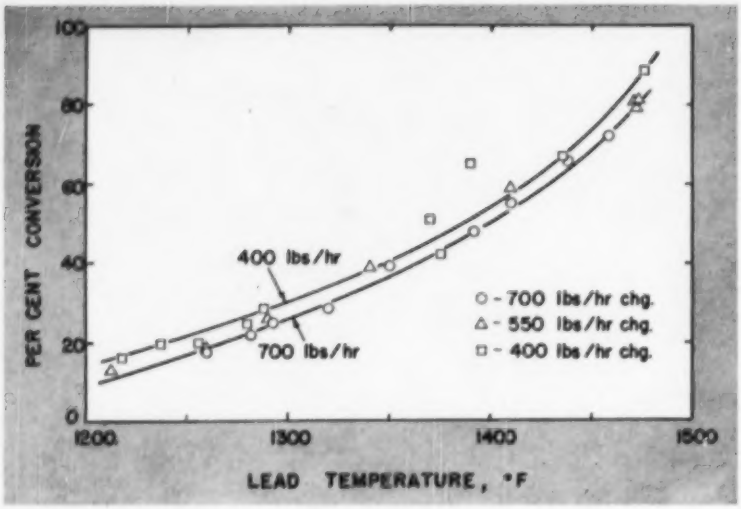



Fig. 10. Effect of gas rate and lead temperature on propane conversion.

area of coke formation was the transfer line to the quencher.

There was some lead loss during experimental operation, but this was attributed to entrainment during impracticably high throughput rates. As noted above, this lead was picked up in the quench water circulating system.

No other unusual operating conditions were encountered; the unit ran smoothly at all combinations of experimental conditions.

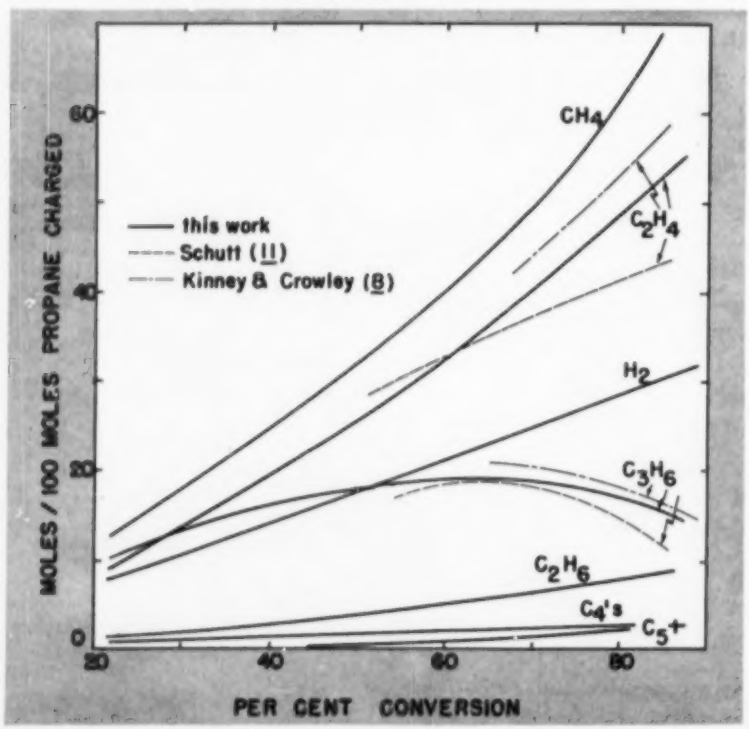
## Discussion

A composite plot of once-through molal yields for this work is given in Figure 11. In the conversion range of commercial interest, comparison is made with the data of Schutt (*11*) and of Kinney and Crowley (*8*) for tubular units. It is apparent that no catalytic effects are present in the lead bath and that to all intents and purposes the yields are equivalent. There may be some differences in primary reaction distribution, but this effect does not prevail at practical pyrolysis depths.

Reaction kinetics calculations confirm the postulation that the lead bath units operate with near-complete back mixing. The effective average reaction temperature appears to be within 30° F. of the measured lead temperature; thus, excellent transfer of heat between lead and gas takes place.

Comparisons between tubular and lead bath units were made in the course of this investigation, but such comparisons involved economic considerations outside the scope of this paper. It may be said, however, that yield structures for the two devices are equivalent and that coking problems with the lead bath unit were not found to be significant.

Fig. 11. Composite yields, propane pyrolysis in a molten lead bath.





## Acknowledgment

Additional participants in this work included Messrs. R. C. Rich, C. C. Nathan, H. E. Reiley, and J. E. Rex. The authors wish to thank the Plastics Division of Monsanto Chemical Company for granting permission to publish this paper.


## Notation

$F$ = molar rate of feed, lb. moles/hr.
$k$ = reaction velocity constant, lb.moles/(hr.)(cu.ft.)(lb./sq.in.abs.)
$r$ = reaction rate, lb. moles/(hr.)(cu.ft.)
$V_R$ = free reactor volume, cu.ft.
$\Delta X_A$ = fractional conversion of species A
$\pi$ = total pressure, lb./sq.in.abs.
$\delta$ = molar expansion factor, moles expansion/mole converted

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*Presented at A.I.Ch.E. meeting, Baltimore, Maryland.*

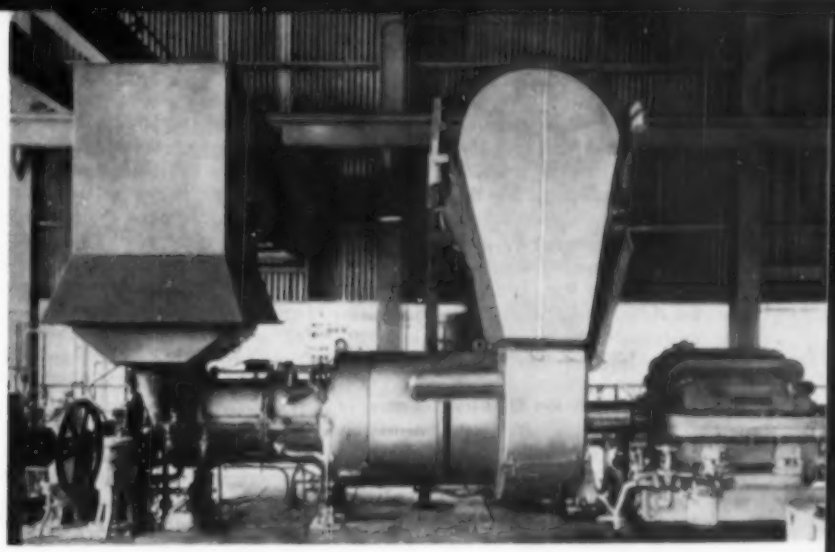


Fig. 4. GE 5,700 hp. simple-cycle single-shaft gas turbine driving compressors.

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General Electric Company,
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# GAS TURBINES IN THE CHEMICAL INDUSTRY

The continual growth of the chemical industry over the years has meant not only an increased number of chemical plants but also an increase in the size of these plants. Today's large plants, and tomorrow's even larger ones, have placed increased emphasis and importance on the varied utility requirements for the various processes. The magnitude and diversity of these utility requirements, such as electric power, heat for process, shaft power to drive pumps, compressors, etc., present a challenge to the prime mover industry. This challenge can be and has been met by the gas turbine which is ideally suited to fulfill the stringent demands of the chemical industry for more economical plant operation.

### How the Gas Turbine Works

In order to understand more fully how the gas turbine can be effectively integrated into the chemical processes, a brief description of operating principles will be helpful. A General Electric 7,000 hp. simple-cycle, single-shaft gas turbine is shown in cross section in Figure 1.

**Atmospheric air is compressed to approximately six atmospheres in the 15-stage axial flow compressor. This compressed air passes into the combustion chamber where it is heated to the required turbine inlet temperature by the burning fuel. GE gas turbines are designed to operate on either natural gas, distillate oil, dual fuel, specification residual oil (Bunker "C"), or many low energy gaseous fuels. The resultant hot gases at 1,400 to 1,500° F. expand through the turbine, developing the power to drive the compressor and the load. Exhaust temperatures from the simple-cycle machine are in the range of from 800 to 900° F., and the heat contained therein can be utilized in many ways. The speed range of the single-shaft machine is adequate for many applications in the chemical industry; however, for applications that require a wider range of prime mover speed, a two-shaft gas turbine can be utilized. In a two-shaft unit, the high pressure turbine which drives the compressor and the low pressure turbine which drives the mechanical load are mounted on independent shafts assembled in one casing. A cross section of the two-shaft machine is shown in Figure 2.**

The simplicity and extremely few wearing parts of this self-contained prime mover, as can be seen in Figures 1 and 2, provide the basis for the gas turbine's inherent reliability and low maintenance requirements.

### GE Operating Experience

The General Electric Company alone has shipped 127 gas turbines and has 75 units on order. These range in size from 5,000 hp. to 30,400 hp. (3,500 kw. to 21,800 kw.) and are utilized in the applications listed in Table 1.

The reliability of the gas turbine is now well established. As of the first of this year, GE gas turbines had accumulated the equivalent of 170 continuous machine years of operation, or over 1½ million hours of service.

The first combustion gas turbine-generator to be installed in the United States is located at the Belle Isle Station of the Oklahoma Gas and Electric Company. This unit has operated for more than 37,000 hours and has been run at more than 25 percent above its nameplate rating over the entire operating period. Latest report indicates that this machine has experienced only two forced outages, for a total of 34 hours, in its first 34,000 hours of operation. Thirty hours of this forced outage time was accounted for by the failure of an oil pump impeller. This report also indicates that a second unit installed in the same plant has operated for roughly three years with no forced outages. The maintenance cost on the initial unit, as reported by the company, averaged $2.05 per installed kilowatt per year for the first 30,000 hours of operation. Included in this figure are some of the costs associated with the development of this first installation of a new type prime mover.

One of the largest gas turbine stations in the world is the Creole Petroleum Company's Lake Maracaibo, Venezuela installation. In this station, 10 GE 6,000 hp. simple-cycle, two-shaft gas turbines are mounted on a platform in the middle of Lake Maracaibo for the purpose of driving centrifugal compressors to repressurize an oil field located under the lake. In the first 13 months of service, the operating log for these 10 gas turbines indicates an availability of 98 percent for the gas turbines, and except for planned maintenance, the platform never had to be shut down due to a gas turbine outage. Figure 3 is a photograph of this station. The advantages of light weight, compactness, reliability, and low maintenance for an installation such as this can be readily appreciated.

* Mr. Weiner is Product Planner in the Gas Turbine Department.

Another large user of gas turbines is the natural gas transmission industry. Natural gas companies alone operate 63 GE gas turbines for natural gas transmission. Availability of gas turbines in pipeline pumping service has been between 97 and 99 percent.

The foregoing figures all serve to indicate that the gas turbine's inherent reliability and low maintenance requirements are being realized in actual on-the-line service.

### Applications in the Chemical Industry

Gas turbines are installed or on order for application in a variety of chemical processes throughout the country. These processes include butadiene, ethylene, nitric acid, and many others. One of GE's first installations in the petroleum refining industry was in an Esso Standard Oil Company refinery in 1953. A 5,700 hp. simple-cycle, single-shaft gas turbine is used to drive centrifugal compressors in this light-ends plant process (see Figure 4). The turbine exhaust is used in an unfired exhaust heat boiler to generate low pressure steam for the process. This machine has operated for 27,661 hours in the period from initial operation on November 17, 1953 to January 31, 1957 for a machine availability of approximately 98.5 per cent. This figure includes all down time, regardless of the cause.

Because complete information is not available concerning the various processes in which gas turbines are operating, it appears that the potentialities of this prime mover can best be exemplified by indicating the services that the gas turbine has to offer and illustrating how these qualifications might possibly be utilized and integrated into the various chemical processes.

**Table 1.—Gas Turbine Applications.**

| Application | Number of units | Combined capacity |
|---|---|---|
| Locomotive | 59 | 473,900 hp. |
| Pipeline pumping (natural gas) | 69 | 361,600 hp. |
| Power generation | 44 | 350,500 kw. |
| Chemical | 9 | 94,300 hp. |
| Pipeline pumping (crude oil) | 13 | 91,000 hp. |
| Oil field repressurizing | 11 | 65,700 hp. |
| Refinery | 1 | 7,000 hp. |
| Ship propulsion | 1 | 6,600 hp. |
| U.S. Navy (supercharged boiler) | 1 | 205,000 #hr./air |

### NITRIC ACID PROCESS

Figure 5 is a composite schematic diagram which illustrates the extreme versatility of the gas turbine. In addition to shaft output, the machine can supply high pressure air, heated exhaust gas, or preheated combustion air. Under the proper conditions, the combustion system can be eliminated, and the full air flow of the compressor can be directed to the process. This is illustrated in the simplified nitric acid process incorporating a gas turbine shown in Figure 6. Here, the full air flow of the turbine's axial flow compressor is directed to the nitric acid process through an intercooler and turbine driven boost compressor. Waste gas from the acid absorption tower (roughly 80 per cent of the original air) enters a catalytic combustion chamber where fuel is added to raise the temperature of the gas from approximately 900° F. to 1,450° F. (This operation also reduces the NO and $NO_2$ in the waste gas to limit air pollution.) This high temperature waste gas is expanded through the gas turbine which provides the shaft power to drive the axial flow and boost compressors. The exhaust gas from the turbine then flows through the exhaust heat boiler where process steam is generated.

**A typical 7,000 hp. gas turbine can generate 40,000 lb./hr. of 150 lb./sq.in. gauge saturated steam in an unfired exhaust heat boiler. Process requirements for greater steam flows can be satisfied by using a supplementary fuel-fired boiler. Under these conditions, the gas turbine exhaust can be used as highly preheated combustion air, as it contains roughly 80 per cent of the oxygen available in standard air. When the exhaust of a 7,000 hp. gas turbine is utilized in this manner, it contains ample oxygen for a fuel-fired boiler to generate over 300,00 lb./hr. of steam at a wide range of temperatures and pressures.**

Electric power generation can also be incorporated in this application by using a split flow, air extraction cycle as illustrated in Figure 7. This is similar to the previous nitric acid cycle except that a larger compressor and a two-shaft turbine are used. The high pressure air flow is split at the compressor discharge. Part of the flow goes to the process through a motor-powered boost compressor, and the remainder enters a standard gas turbine combustion system. The products of combustion from the combustion chambers are then combined with the waste gas from the process before entering the turbine. The amount of power generation required would dictate the size of compressor and turbines used. The higher mass rate of flow in this system would considerably increase the process steam generating capability of the exhaust heat boiler.

### BUTADIENE

The gas turbine can also be effectively applied in the dehydrogenation process for producing butadiene. Figure 8 indicates one method of using the turbine exhaust gas as highly preheated, pressurized air for reactor catalyst regeneration. In this process, the catalytic reactors undergo a dehydrogenation period, a regeneration period, and a steam purge period. A butadiene system utilizing seven reactors would have three reactors on regeneration at any given time. The regeneration of the catalyst consists of burning off built-up carbon deposits and leveling the temperature of the catalyst bed. Steam for the catalyst purge can be supplied by the waste heat boiler. Although Figure 9 shows two back pressure gas turbines supplying the regeneration air, the same purpose may be accomplished with one large unit.

An alternate method of applying the gas turbine to the butadiene process is to direct the compressor air flow through an air heater to the reactors undergoing regeneration. The reactor exhaust gas, containing considerable excess oxygen, is brought up to the desired turbine inlet temperature in a combustion chamber before expanding through the turbine which drives both the compressor and the load. The load can either be a generator or one of the gas compressors required in the process. This cycle is illustrated in Figure 9.

### CATALYTIC CRACKING

Fluid catalytic cracking is another operation in which gas turbines can be advantageously used. One form of applying gas turbines in this process is shown in Figure 10. One turbine drives a centrifugal compressor supplying combustion air to the regenerator while another turbine drives two intercooled centrifugal compressors which pressurize the wet gas from the fractionator. Both turbines exhaust to a common exhaust heat boiler supplying saturated steam for the system's stripping operation. A refinement of this cycle, which would incur

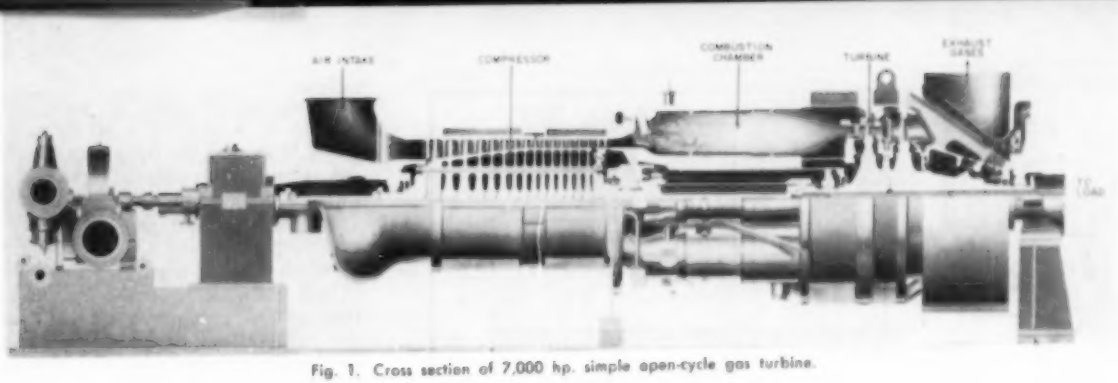



Fig. 1. Cross section of 7,000 hp. simple open-cycle gas turbine.

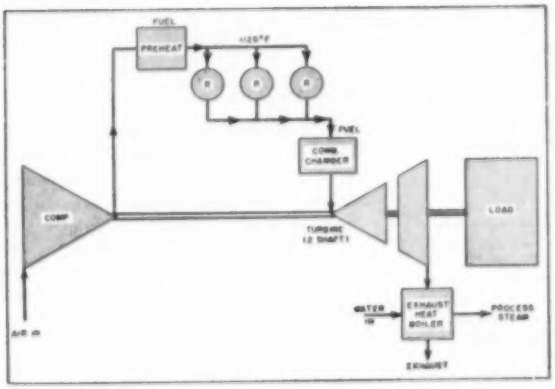



Fig. 9. Gas turbines for catalyst regeneration.

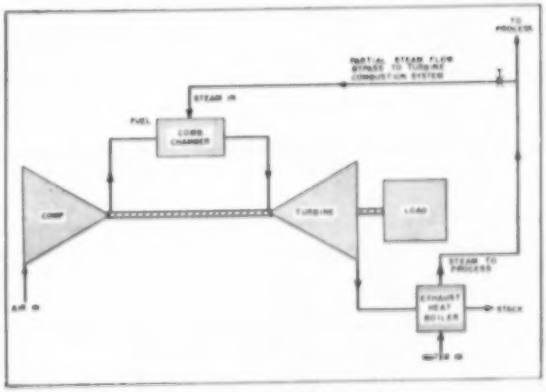



Fig. 12. Steam injection cycle.

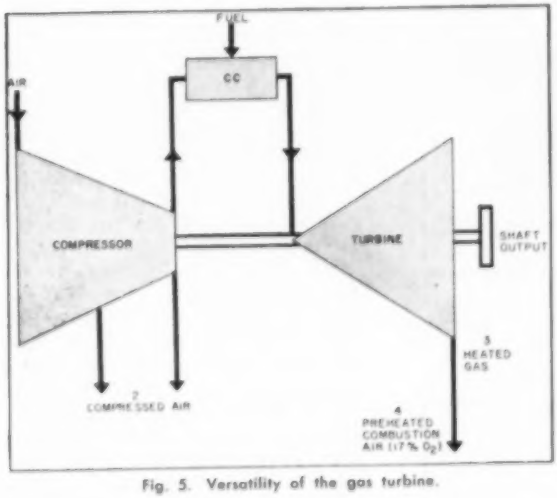
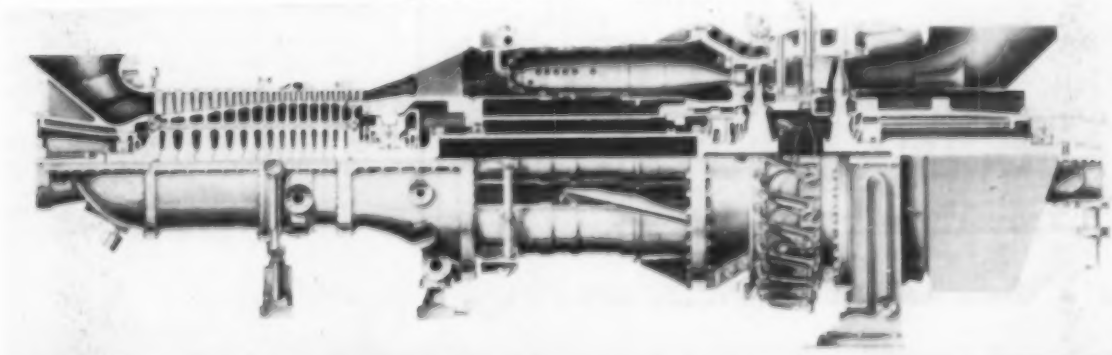



Fig. 5. Versatility of the gas turbine.



Fig. 3. Ten GE gas turbines mounted on Creole Petroleum's pressure maintenance platform over Lake Maracaibo.

Fig. 2. Simple-cycle, two-shaft gas turbine.



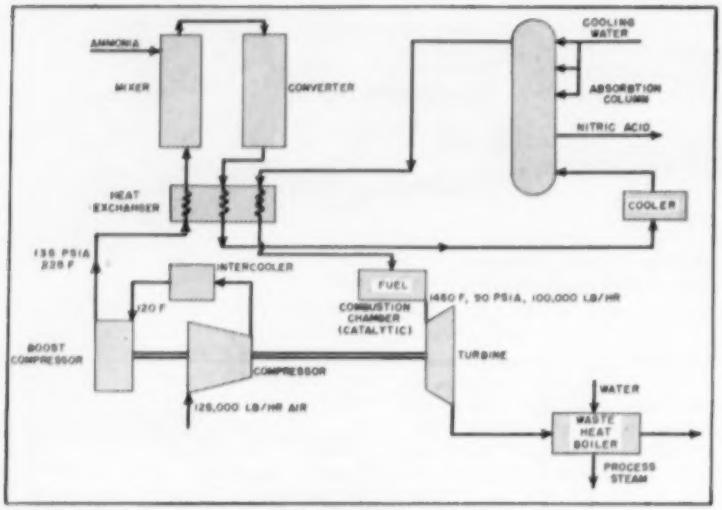



Fig. 6. Gas turbines in nitric acid process.

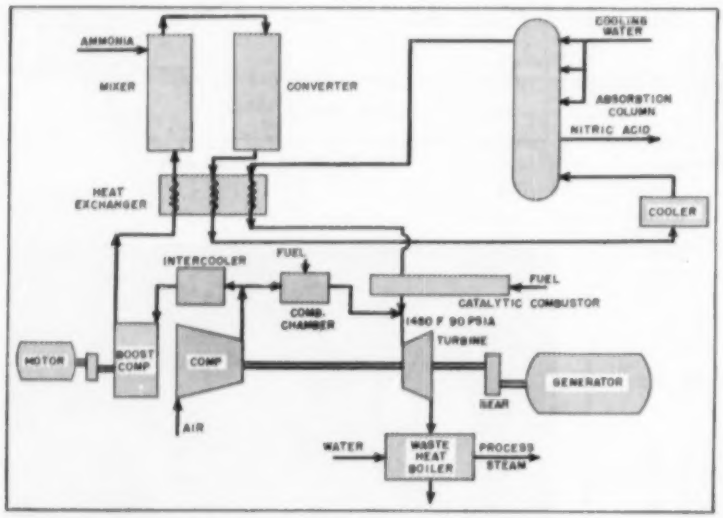
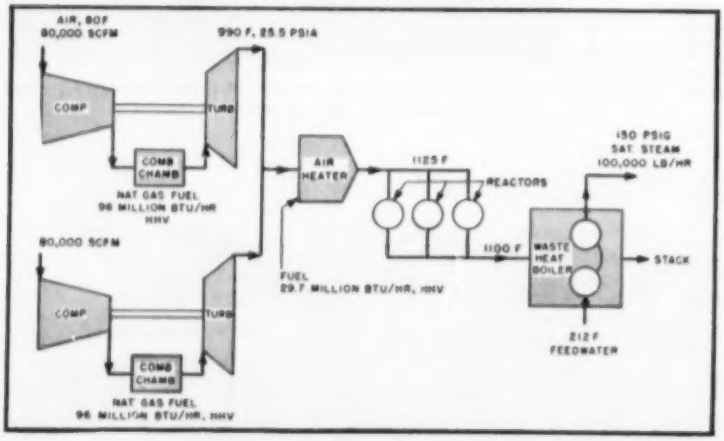



Fig. 7. Gas turbines in nitric acid process.

Fig. 8. Gas turbines for catalyst regeneration.




a significant increase in plant efficiency at a nominal cost increase, would be to pass the hot process stack gas from the catalyst regenerator through a gas turbine regenerator (not shown). The gas turbine regenerator is basically a heat exchanger in which exhaust energy in the form of heat is transferred to the high pressure turbine combustion air between the compressor discharge and the combustion chamber inlet. For a given machine, this will require that less fuel be burned in the combustors for a given turbine inlet temperature, thereby increasing the overall thermal efficiency of the unit.

### ETHYLENE

The production of ethylene requires a large amount of shaft horsepower in the form of process compressor drive. Figure 11 indicates the utilization of a gas turbine to supply this power efficiently. The turbine in this very simplified version of an ethylene plant drives four series-flow centrifugal compressors in tandem and exhausts through an unfired boiler to supply steam for the process. Other compressor drive requirements in the refrigeration cycle can also be adequately supplied by a gas turbine.

Many chemical processes, such as the ethylene process mentioned above, give off substantial volumes of low or intermediate energy combustible gas. Many of these gases constitute excellent gas turbine fuels. Where the off-gas is available at high pressures, on the order of 150 lb./sq. in. gauge, it is feasible to start the gas turbine on natural gas or oil fuel and switch over to process off-gas fuel when it becomes available. Where the volume of off-gas is not sufficient to meet the full fuel requirements of the gas turbine, it can be used as a supplementary fuel and burned in combination with natural gas or with oil in a dual-fuel machine. GE dual fuel burning gas turbines are presently in operation and exhibit excellent performance. A system operated in this manner can be made partially, or completely self-sustaining. When the process off-gas is available at pressures lower than 150 lb./sq. in. gauge, it will in general be necessary to install a suitable gas compressor and required accessories capable of increasing the off-gas pressure to the required turbine combustion system level.

In many chemical processes, a large quantity of process steam is required and must be available at all times. It is possible to utilize some of this steam in the gas turbine to supply in-

creased power that may be required for the peak power demands of the system. In this application, the gas turbine's rated output is determined by the normal power requirements of the plant. During periods of power demands in excess of normal requirements, steam is injected into the gas turbine combustion system from the exhaust heat boiler. This can be accomplished with a simple manual control and a metering orifice, or semi-automatic control if desired. The gas turbine cycle is shown schematically in Figure 12. By injecting steam in this manner, it is possible to increase the output of the gas turbine by roughly 40 per cent more than the 80° F. rating with the induction of 10 per cent steam. (The 10 per cent steam refers to a mass ratio of steam to turbine exhaust gas flow.)

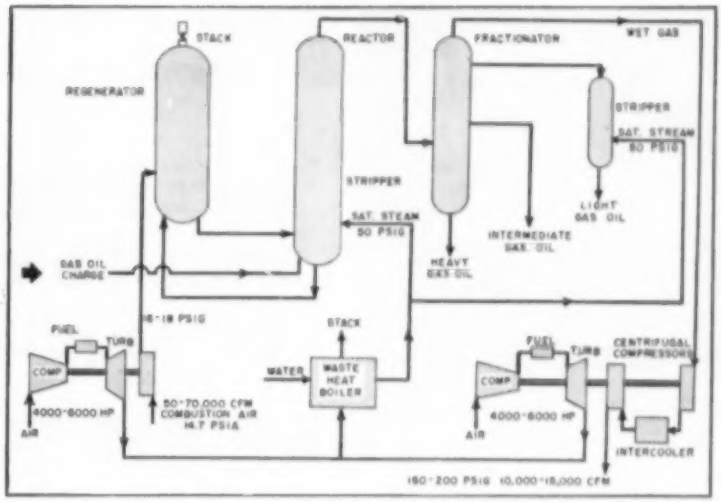



Fig. 10. Schematic diagram of a fluid catalytic cracking process using gas turbines.

## CHLORINE

Production of chlorine by electrolysis accounts for the major amount of this chemical's manufacture. This method of production utilizes large quantities of d.c. power and steam. Figure 13 shows one system of applying gas turbines in conjunction with a steam turbine to supply these requirements economically. In this application, three 4,500 kw. gas turbine-generator sets are used to generate 13,500 kw. of d.c. power and supply heat to the three dual exhaust heat boilers. The three dual boilers generate 25,500 lb./hr. of 25 lb./sq. in. gauge saturated steam for process and 90,000 lb./hr. of 400 lb./sq.in. gauge 750° F. steam for the steam turbine working fluid. After expanding through the steam turbine-generator and producing another 4,500 kw. of d.c. power, this steam flow is also directed to the process. In total, this arrangement nets 18,000 kw. of d.c. power and 110,200 lb./hr. of process steam.

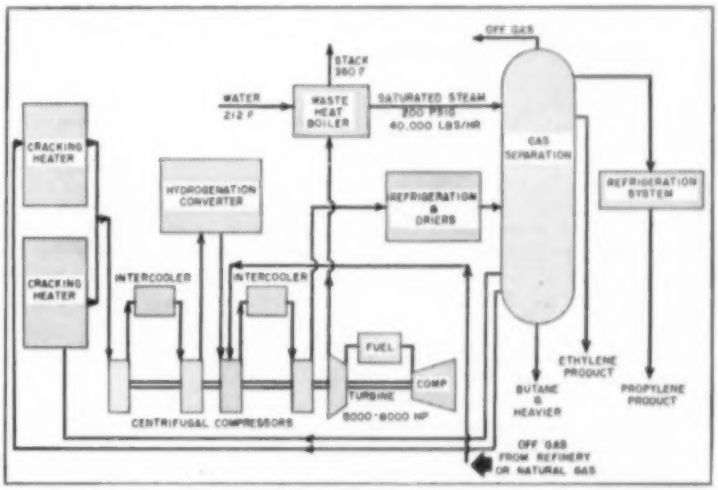
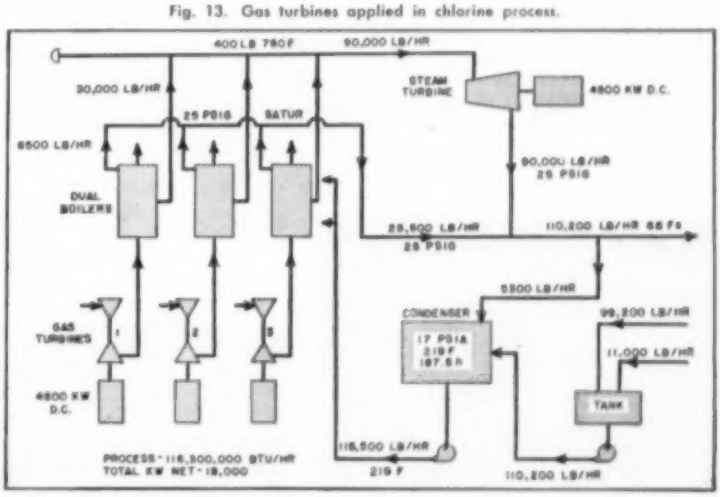


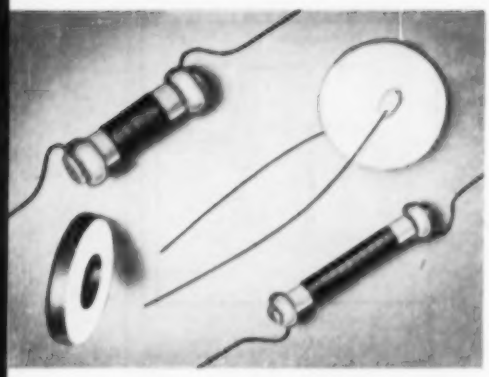

Fig. 11. Simplified ethylene plant incorporating gas turbine.

## OTHER APPLICATIONS

The illustrations shown above are but a few of the almost limitless possibilities in which the versatility of the gas turbine can be profitably employed by the process engineer. Studies show that the gas turbine can also be effectively integrated in the acetylene, ethylene oxide, methanol, tonnage oxygen, coal hydrogenation, and many other processes. Although the major emphasis here has been on integrated process applications, the coming years should also see a large amount of the extensive electric power requirements of the chemical industry supplied by gas turbine-generator sets.

Fig. 13. Gas turbines applied in chlorine process.





Typical thermistors.
(Courtesy G.E.)

# MEASUREMENT AND CONTROL OF LIQUID LEVEL BY THERMISTORS

**Ceramic electrical resistors, called "thermistors," may be used to control or measure the level of liquid in a tank or, as an alternative to measurement, they can detect safe, unsafe, and threshold regions. The fundamental operating principle is the change in resistance of the thermistor caused by cooling on immersion.**

*A. B. Soble* | Stevens Institute of Technology, Hoboken, New Jersey

A thermistor is a ceramic whose electrical resistance decreases exponentially with increasing temperature—a characteristic which may be taken advantage of in the measurement and control of the liquid level in a tank.

The *control* is absolute: any level can be achieved and maintained. On the other hand, the *measurement* may be either absolute or relative: one technique permits measuring the level exactly; another technique determines only the region in which the level lies (such as safe, unsafe, and threshold regions). But whether for measurement or control, the same fundamental principle applies: if a thermistor is heated (by an electric current flowing through it) to a temperature higher than that of the liquid, then wetting by the liquid will cool the thermistor, increase its electrical resistance, and reduce the current flowing through it.

### Region Signal

In the problem of detecting three regions of liquid level (namely safe, unsafe, and threshold) by the illumination of green, red, and yellow lights respectively, the region boundaries are marked in the tank by two fixed thermistors, $A$ and $B$. (See Figure 1.)

**When thermistor A is wetted, the green light on an office panel is illuminated. (See Figure 2.)**

**When thermistor B is wetted, but not A, the yellow light on the panel is illuminated.**

**When thermistor B is not wetted, the red light on the panel is illuminated.**

Required to complete the electric circuit is a battery, or other supply of constant d.c. voltage, as in Figure 3.

Let $R,Y,G$ be the resistances, when illuminated, of the red, yellow, and green lights, respectively (or the resistances of the lights and constant resistances in series with them).

Let the resistances of thermistors $A$ and $B$ be $A_{dry}$, $A_{wet}$, $B_{dry}$, $B_{wet}$, and let

$$G > Y > R \tag{1}$$

$$A_{wet} > G - Y \tag{2}$$

$$B_{wet} > Y - R > B_{dry} \tag{3}$$

$$G - R > B_{wet} + A_{dry}. \tag{4}$$

From (2),

$$G < A_{wet} + Y$$

and from (3),

$$Y < B_{wet} + R$$

so that

$$G < A_{wet} + Y$$

and

$$G < A_{wet} + B_{wet} + R$$

Hence, when $A$ is wetted, only the green light is lit. From (4) and (3),

$$G > A_{dry} + (B_{wet} + R) > A_{dry} + Y.$$

Hence, when $B$ is wetted, but not $A$, only the yellow light is lit. Since

$$G > A_{dry} + Y$$

Hence, from (3),

$$G > A_{dry} + Y > A_{dry} + B_{dry} + R.$$

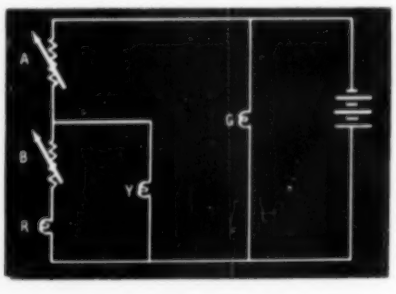
◄ Fig. 1.




Fig. 2. ▼




Fig. 3. ►



# GENERAL CHARACTERISTICS OF THERMISTORS

Thermistors are electronic semiconductors whose electrical resistance lies between that of conductors and insulators. In contrast to metals, which have small positive temperature coefficients of resistance, thermistors have large negative temperature coefficients. This fact, combined with their non-linear resistance characteristics, enables them to perform a wide variety of regulatory functions.

Figure 1 illustrates the changes in resistance in two grades of thermistor material over a 500° Centigrade range of temperature, compared to a representative metal. In some types of thermistors, it is possible to double the resistance with a temperature change of as little as 17° C.

### Characteristics of Material

Table 1 lists some of the characteristics of two thermistor materials produced by General Electric. The thermistors are made in three main types: rods, discs, and washers. The raw materials—manganese, nickel, and cobalt oxides—are milled and then mixed in accurate proportions. Suitable binders are added and the units are pressed or extruded to the desired shape. The thermistor elements are then sintered under carefully controlled atmospheric and temperature conditions to produce a hard ceramic-like material. Silver paste terminals are applied and fired on. When desired, lead wires are soldered to the silver paste with a soft solder containing approximately 12 per cent silver.

### Stability

Stability tests have been carried out by GE on ¾-in. diam. disc types of Grade 1 and Grade 2 material with silver contacts and soldered leads. The tests were made immediately following manufacture and the elements were oven-aged at 105° C. and tested periodically at 24° C. Percentage of change in resistance over the initial value was plotted against the logarithm of oven time (Figure 2). The tests indicated that most of the aging occurs during the first day or, at most, during the first week. Had the thermistors been pre-aged for a week to a month and the subsequent change in resistance been used as a guide to stability, their age rate per year would be only about 0.2 per cent. In a thermistor thermometer, this rate of change in resistance would approximate a temperature change of about 0.05 per cent. Thermistors operating in a vacuum or shielded with a coating of thin glass age at a lower rate than the units tested.

### Types of Application

In general, thermistor applications have two broad classifications:

- When the element is controlled by the ambient temperature. This group includes applications in the field of temperature measurement and control, and temperature compensation.
- When the element is heated by the current in the circuit with which it is associated. This category includes cases where various combinations of voltage-current and current-time characteristics are involved. Such applications include various time delay devices for relay operation, timing devices, sequence switching, safety, and warning circuits.

Representative manufacturers of thermistors are: Carborundum Co., Ferroxcube Corp. (agents for Phillips of Holland), General Electric, Keystone Carbon, Victory Engineering, and Western Electric.


### Acknowledgment

Technical data and curves reproduced above were kindly furnished by the Magnetic Materials Section of General Electric Co., Edmore, Michigan.

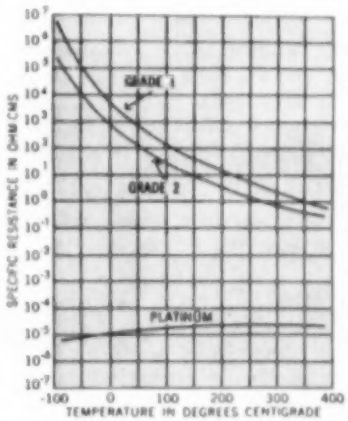




Fig. 1. Temperature resistance values of two grades of GE thermistors compared to a representative metal.

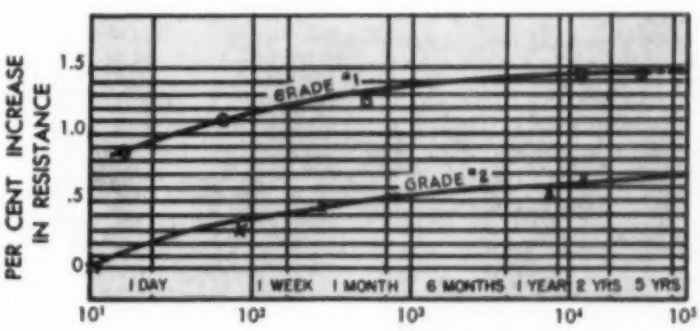
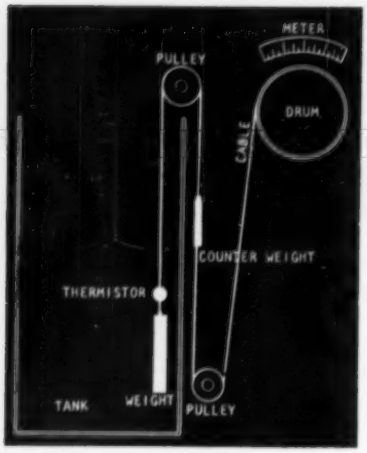



Fig. 2. Stability aging curve (discs) for GE thermistors, Grades 1 and 2.

Table 1.

| Material | Specific resistance at 25° C. ohm-cm. | Beta 25° C. to 75° C. deg. Kelvin | Thermal resistivity deg. C. × sq.in. / watts × in. | Thermal conductivity B.t.u. × in. / deg. F. × sq.ft. × hr. |
|---|---|---|---|---|
| No. 1 | 2,100 ± 10% | 3,965 ± 55 | 29.4 | 9.4 |
| No. 2 | 300 ± 10% | 3,530 ± 80 | 20.2 | 13.5 |




◄ Fig. 4.




Fig. 5. ▲

Thus, when neither *A* nor *B* is wetted, only the red light is lit.

A problem similar to the foregoing is the detection of four quarter regions of liquid level—less than ¼ tank capacity, between ¼ and ½, between ½ and ¾, and more than ¾—by the illumination of white, green, yellow, and red lights respectively.

**Level Signal**

If, instead of detecting only a region, it is necessary to measure a precise level, the mechanical system of Figure 4 and the electrical circuit of Figure 5 may be used.

A weight and thermistor are suspended inside the tank by a cable which passes through a pulley above the tank and a lower pulley outside the tank, the end of the cable being wound on a spring-loaded solenoid-operated drum. Rotation of the drum is read on a meter which is calibrated in units of liquid level. Electric current through the solenoid causes the drum to unwind the cable. Between the two pulleys, and outside the tank, is suspended a counterweight slightly lighter than the weight suspended inside the tank. Hence, unwinding the cable lowers the thermistor.

When the thermistor is above the liquid level, it has low resistance. Being heated by the electric current flowing through it, its resistance becomes less and permits more current to flow both through it and through the solenoid. (See Figure 5.) The solenoid then unwinds the cable, and the thermistor is lowered into the liquid.

When the thermistor is below the liquid-level, it is cooled by the liquid, its resistance increases, current ceases to flow through it, the solenoid ceases to operate, and a spring winds the drum and cable, raising the thermistor.

This is effectively an on-off control for stabilizing the position of the thermistor at liquid level and for stabilizing the position of the drum and meter needle.

**Level Control**

The method of the preceding example can be modified to control the inflow and outflow valves so as to change or maintain a pre-assigned liquid level. In this case, however, the drum position is pre-set manually (only one pulley and no counterweight are needed) and a coil of high-resistance wire is put in parallel with the thermistor. (See Figures 6 and 7.) The valves are spring-loaded, so that when no current flows through a valve solenoid, the spring holds it closed.

To select a liquid level, the drum is turned manually to the position in which the meter shows the desired setting. Turning the drum causes the thermistor and high-resistance coil to be at the desired liquid level.

If both thermistor and high-resistance coil are *above* the liquid, the thermistor has low resistance and the resistance coil has high resistance. Current therefore flows through the thermistor instead of the resistance coil. The current through the thermistor also flows through the inlet valve solenoid, opening the valve and admitting more liquid.

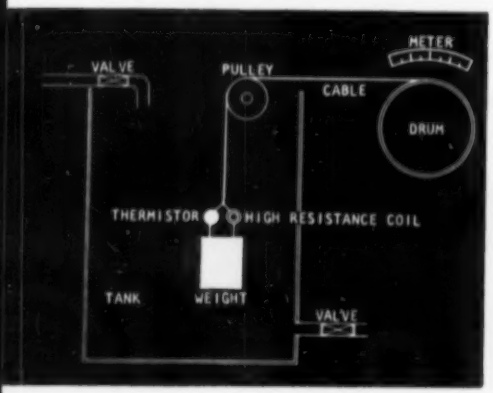
If, on the other hand, both thermistor and high-resistance coil are *below* the liquid, they are cooled by it, and the thermistor will have high resistance, while the resistance coil will have comparatively low resistance. Hence, current flows through the resistance coil instead of the thermistor. The current through the resistance coil also flows through the outlet valve solenoid, opening the valve and letting liquid escape.

Again, this is effectively an on-off control for stabilizing the liquid level at the pre-assigned position of thermistor and resistance coil. The system has been designed so that current opens the valves. If the battery fails, there is no current in either solenoid, and liquid flows neither in nor out: the system is fail-safe.

**Comment**

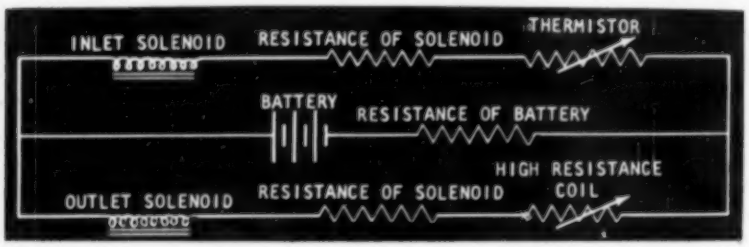
Although the foregoing examples assume that the thermistor is heated above the temperature of the liquid, the technique can be modified if the liquid is at higher temperature than the thermistor.

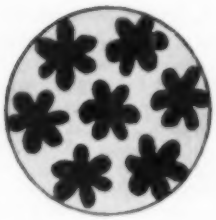
A bibliography on thermistors is contained in the article "Thermistor Compensation of Resistance and Conductance," *IRE Trans. on Components*, September, 1957.

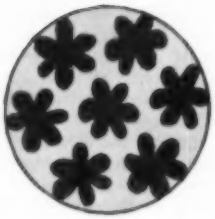



◄ Fig. 6.

Fig. 7. ▼







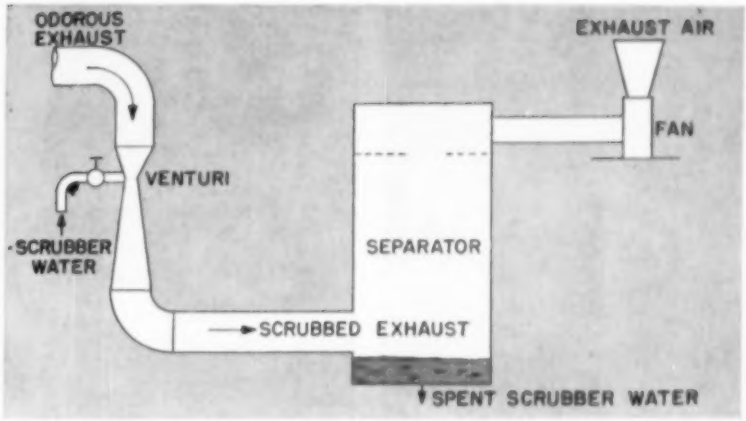


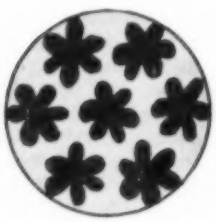

Fig. 1. Venturi scrubber system.

The effectiveness and economics of a Venturi scrubber for odor control has proven quite satisfactory in the particular application described in the accompanying article. However, authors recommend pilot unit tests on each individual service to determine the efficiencies and design criteria so that the Venturi can be properly evaluated in comparison to other methods of odor control. Byrd and Dewey believe a 100 cu. ft./min. unit should be adequate in predicting the performance of a full-scale unit.

# VENTURI SCRUBBER IN ODOR CONTROL

*J. F. Byrd and E. L. Dewey*

The Procter & Gamble Company
Cincinnati, Ohio







The Procter & Gamble application of the Pease-Anthony Venturi scrubber is probably unique. The particulate-matter loading of the exhaust being treated by this device is slight, that is, well within the legal limits of air pollution control rules and regulations. Deposition of particles in the neighborhood has never been a problem. The need for the Venturi scrubber has been due exclusively to a potential odor nuisance.

Although this article covers a specialized use in the soap and detergent industry, the general principles (outlined below) should prove at least a qualitative guide for almost all services. In fact, the Venturi scrubber can be found in such diverse services as the removal of salt cake fume from sulfate recovery furnace stack gases, the elimination of the dust nuisance from steel furnaces, and the recovery of sulfuric acid mists.

The particular application discussed here involves a mildly odorous exhaust which carries entrained product fines. In addition, the exhaust air contains liquid aerosols and vapors consisting of either unreacted constituents from the process or products of decomposition from the elevated processing temperatures. It is these constituents rather than the product fines or dust which contribute to the odor level. Passing through centrifugal separators or cyclones, the air loses about 97% of the dust present and then has a dust loading varying from .05 to .1 grains/cu.ft. Although this loading is normally considered relatively low, an occasional nuisance problem still can arise in the neighborhood due to the large volume of air emitted to the atmosphere.

Therefore, a secondary or polishing device is desirable to reduce the grain loading further, a device which may be either a packed scrubber, cyclone scrubber, or possibly a baghouse filter. However, the minute quantities of submicron liquid aerosol and gaseous compounds are not removed by any of these units. The exhaust discharge to the atmosphere has a characteristic mild odor which can constitute a

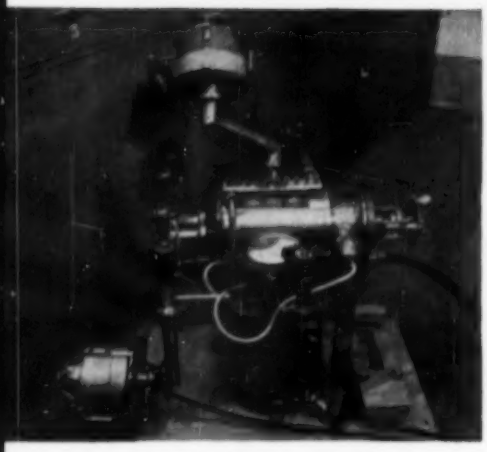


Fig. 3. Photograph of Osmo.

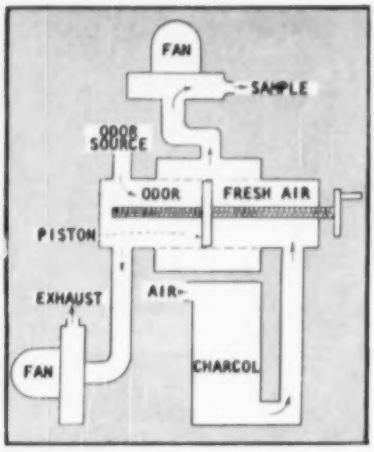



Fig. 2. Diagrammatic representation of Osmo device for measuring odors.

nuisance. On warm, dry days when the moisture in the exhaust does not condense out and mask the true nature of the emission, an unobtrusive, sometimes bluish haze usually can be observed. Neither a packed water scrubber nor a cyclone scrubber was able to remove an appreciable quantity of the fumes. Both devices handle efficiently particulates of greater than one micron in size. Therefore it is reasoned that the fumes emitted are submicron in size. Other indirect data seem to confirm this deduction. However, no measurements have been made due to the difficulties in handling liquid aerosols and the fleeting nature of such fumes.

The odor was somewhat abated by the use of odor furnaces, but the necessity of heating up such large volumes of exhaust air and gases to get at the small quantities of odor-producing material involved considerable fuel costs and provided an incentive for utilization of a less expensive and more effective means of odor abatement.

### Early Days of Venturi Scrubber

At that time when means and methods of abating odor were expensive, the Venturi scrubber had already been developed and was showing much promise. This device was patented by the Pease-Anthony Equipment Company of Newtonville, Massachusetts. The principle was applied first at the Thilmany Paper Mill in Kaukauna, Wisconsin, for purposes of scrubbing a salt cake fume from a black liquor furnace of a Kraft Paper process (*3*). The salt particles were generally in the submicron-size range. The next application was at the open-hearth furnace at Republic Steel for purposes of removing the iron oxide dust from the furnace exhaust. The performances for these two applications indicated excellent prospects for the particular needs of the P&G company. At present, of course, the Venturi scrubber is widely applied and there are numerous units in operation.

As the name suggests, the Venturi scrubber consists of little more than a Venturi tube (Figure 1).

### Details of Venturi Scrubber

The gases to be scrubbed are passed through the tube where low pressure water, 5 to 10 lb./sq.in., is injected into the gas stream at the high velocity throat section. Throat velocities are usually in the order of 250 ft./sec. or higher (about 170 miles/hr.). At these high throat velocities the gases shear and break the injected water into a fine spray. The atomized water particles collide with the entrained particulate matter in the throat region of extreme turbulence, and this compaction between the particulate matter and the water droplets is aided and abetted by the initially large difference in velocity between the two (*4*). The water particles entrained in the air agglomerate into sizable droplets during passage through the diverging section of the Venturi, a region of reduced velocity. Upon leaving the Venturi the gas-water mixture passes tangentially into an entrainment separator where the water droplets are spun out of the exhaust gas and collect on the vertical walls. The water flows by gravity to the bottom of the separator.

Pilot unit tests undertaken to determine the applicability of the Venturi scrubber to odor abatement resulted in a collection of data gathered from the pilot unit and formed the design basis of a number of full-scale units. The full-scale performance in general checked fairly well with the efficiencies anticipated by the pilot units. These performance curves accompany this article since they have proven applicable to full-scale units.

The two pilot units handled 2,000 and 100 cu.ft./min. respectively. The 100 cu.ft./min. unit was adequate in predicting the capabilities of the actual production units. Therefore, any future tests to determine the applicability of the Venturi for particular services will utilize a 100 cu.ft./min. pilot unit.

The basic problem in the pilot unit tests was the choice of a parameter as a criterion of performance. To be

Fig. 4. Odor removal vs. water rate.

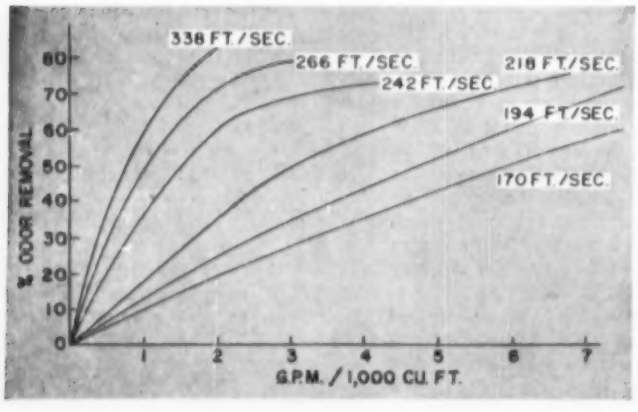
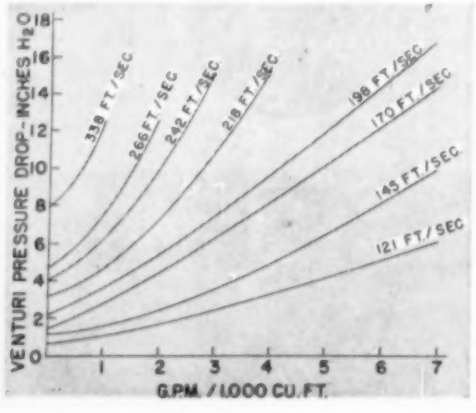



Fig. 5. Venturi pressure drop vs. water rate.



successful, the Venturi must remove the submicron liquid aerosols which caused the odor nuisance. It would seem logical therefore to measure the quantities of these constituents which remained after passing through the scrubber. One possibility was the use of a wet Greenburg-Smith impingement separator in an ice bath followed by a thimble filter. To measure the matter removed in the impingement separator, the water in this separator must be evaporated to dryness. Since the liquid aerosols causing the odors exert a vapor pressure, some losses are inevitable by this technique. Such objections could be obviated by solvent extraction of the trapped organic aerosols from the water component of the impingement separator. However, this procedure is an expensive and time-consuming load on any laboratory due to the large number of runs necessary to obtain adequate performance curves. Also, to obtain enough sample for proper quantitative analysis, a 4- to 6-hr. run was necessary. Such accurate chemical analysis techniques were ruled out in this case as impractical since time was of the essence.

The measurement of light transmission through the fume exhaust became for a time the accepted method of determining the efficiency of performance. The method was quick and detected reasonably small variations in operation. This approach to determining fume scrubber efficiency is based on the Beer-Lambert Law of Optical Density, which states that for a given thickness of solution the concentration of particles in the solution is proportional to the logarithm to the base 10 of the ratio of light transmission through a clear solution to the light transmission through the solution in question.

Although some good design data were obtained by this technique of measuring scrubbing efficiency, certain inherent disadvantages of the method became apparent. The exhaust was saturated with water and on cold days moisture condensed out yielding an aerosol consisting of water particles as well as the undesirable fumes. Data taken under identical atmospheric conditions could be compared, but one day's data could not be so compared to a previous day's performance. Then too, odor reduction is not necessarily proportional to fume reduction. The different components of the fumes are not removed in the same percentages nor are these components necessarily of the same odor intensity. Also, antagonistic and synergistic effects on odor intensity by the different components upon each other are possible. It should be reemphasized that the primary objective was odor reduction rather than particulate loading reduction as such. It has been previously noted that the exhaust was certainly acceptable with respect to particulates when reduced to absolute values of grains/cu.ft.

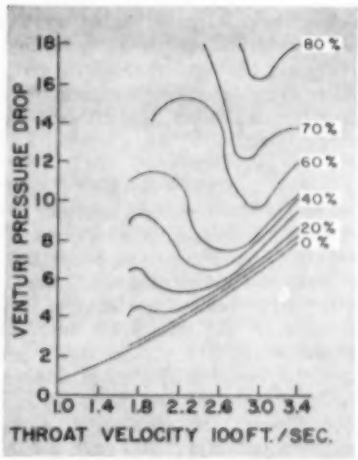



Fig. 6. Constant efficiency curves. Pressure drop vs. throat velocity.



Fig. 8. Schematic sketch of water spray pattern, center nozzles.

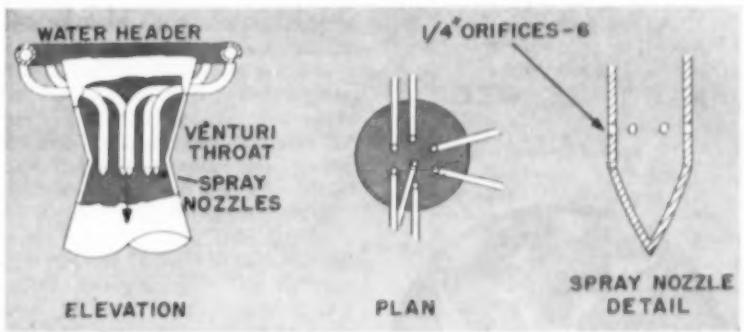



Fig. 7. Center water spray nozzles.

Therefore, it was decided that the best criterion of the effectiveness of the Venturi scrubber for odor control was actual *measured* odor reduction. Methods had been developed for quantitative measurement of odor intensity which, while subjected to the inherent limitations of the human olfactory senses, proved quite satisfactory.

### Odor Measurement

The first prerequisite of any technique of odor measurement is a concept of the unit of measurement (*1*). The odor unit has been established, and one odor unit is defined as the amount of odor necessary to contaminate 1 cu.ft. of clean air to the threshold or barely perceptible level. For example, if a sample or side stream of the emission under consideration contained 5 odor units/cu.ft., the figure merely states that 1 cu.ft. of the sample can be diluted with 4 cu.ft. of odor-free air and the resultant 5 cu.ft. of mixture would still contain a barely detectable odor. In this example the 5 odor units/cu.ft. is analogous to a dust-loading figure; in other words it denotes a concentration.

One device for measuring odors is the Osmo (Figure 3) which has been described in the literature (*5*). For a schematic diagram of the unit, see Figure 2.

The Osmo consists of equipment which delivers to the observer 10 to 20 cu. ft./min. of air which passes through a carbon canister and is therefore odor free. Into this odor-free air varying and measurable amounts of the contaminated exhaust are fed. At the threshold or barely perceptible level, the ratio of clean air to contaminated air necessary to reach this level is a direct measure of the odor intensity of the source.

Most of the results outlined herein are based upon this technique of odor measurement. Due to the cumbersome

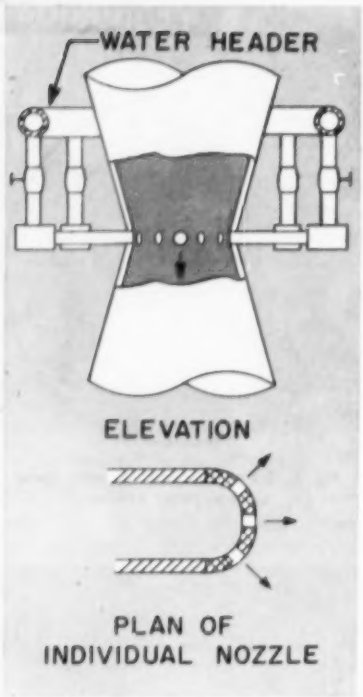



Fig. 9. Side entering nozzles.



Fig. 10. Schematic sketch of water spray pattern, side entering nozzles.

nature of the Osmo, a syringe technique of odor measurement has since been developed (*2, 6*).

So much for the procedures of testing. Next the operating characteristics of the scrubber for the particular exhaust in question will be considered. Although the performance curves are for a specific exhaust, these curves should be at least indicative of what to expect in most services to which the Venturi may be applied.

As may be expected, water rate into the throat of the scrubber and the air velocity through the Venturi throat were the prime factors which determined the odor reduction obtained by the Venturi scrubber, this relationship being indicated in Figure 4. Odor-removal efficiency is plotted against water rate for various air velocities. It should be noted that for a given water rate the odor reduction is greatly improved by increasing the air velocity. At a water rate of 3 gal./min./1,000 cu.ft. and a throat velocity of 170 ft./sec., a 30% odor-removal efficiency is realized. Increasing the velocity by only 40% to 242 ft./sec. better than doubles the odor reduction. For a given odor-removal efficiency of, say 50%, at 3 gal./min./1,000 cu.ft. of scrubbed air, 218 ft./sec. throat velocity is required. Reducing this velocity by only 25% to 170 ft./sec. requires twice the amount of water, nearly 6 gal./min./1,000 cu.ft. air for the same odor-removal efficiency.

The effect of scrubber water rate on the pressure drop of the scrubber air through the Venturi throat is indicated by Figure 5. The scrubber water flow is plotted against the pressure drop through the throat for various air velocities. The pressure drops, in very general terms, vary directly as the water flow rates. In addition, as may be expected, the pressure drop, or power expended, varies as the square of the velocities through the Venturi.

Results from Figures 4 and 5 are combined in Figure 6, which shows the variation of Venturi pressure drop with air velocities for given constant efficiencies. This is a useful curve since it reveals at a glance the optimum velocity and the required pressure drop for any given efficiency. In the middle ranges of odor-removal efficiency it can be generally said that the fumes or odor eliminated from the air stream is about proportional to the horsepower expended. The horsepower can be used effectively by either increasing the throat velocity or by increasing the water rates.

The distribution of water in the throat of the Venturi is quite critical. Good coverage of the entire throat

**THE P & G STORY**

Production line units operate at about 70 to 75% odor-removal efficiency. Fume- and dust-removal efficiency is in the order of 90%. Air velocities in the throat vary from 250 to 300 ft./sec., with pressure drops at about 14 to 16 in. $H_2O$. Scrubber water rate is between 3 and 4 gal./min. for 1,000 cu.ft. air flow.

cross section with the atomized water is a prime prerequisite of efficient operation. Visual observation of the spray pattern in the throat during actual operation is an excellent means of determining if good coverage is being realized. The method of achieving this coverage has little effect on the odor-removal efficiency and there are any number of ways of obtaining a good throat spray pattern.

Most of the Procter & Gamble installations include several pipes descending vertically into the throat of the Venturi where they terminate. Around the periphery of each pipe are orifices which spray the water towards the walls of the Venturi normal to the flow of air. Figure 7 shows such a layout. Figure 8 is a sketch of the flow pattern which can be observed during actual operation. The coverage is much better than that indicated by the sketch which has been simplified for purposes of clarity.

The only disadvantage of the center pipe is the possibility of build-up of the particulate matter on the pipe located in the throat.

This caking of solid material occasionally results in a clogged-up orifice. Such an inoperative orifice destroys the complete coverage of the throat by the water spray. The air passing through gaps in the wall of water is therefore not scrubbed and the over-all efficiency drops considerably. The center water pipes are not accessible during operation. This situation led to the development of the



Fig. 11a. 5.38 gal./min./1,000 cu.ft./min. 50% center pipe, 50% peripheral nozzles.

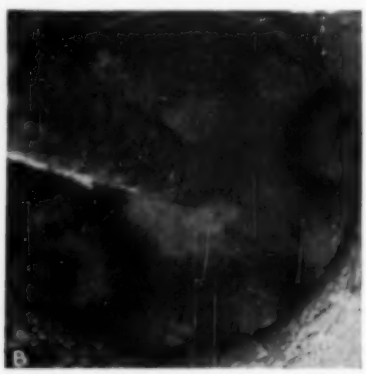


Fig. 11b. 5.38 gal./min./1,000 cu.ft./min. 60% center pipe, 40% peripheral nozzles.

side-entering nozzle system in which the water nozzles are located flush with the walls of the throat and located around the periphery of the throat. Each nozzle contains three orifices: a center one and two angled to each side. Figure 9 reveals the piping layout at the throat for the side-entering system of water nozzles. The spray pattern is revealed by Figure 10.

A combination of the two systems has been used in pilot units. In Figure 11 (a-e) are actual photographs of the coverage. The velocity of the water into the throat is not critical as long as it is sufficient to carry the spray well into the throat. Water at discharge pressures of 5 to 10 lb./sq.in. is adequate for the purposes here. (Photograph exposure time was 1/10,000 sec., all water nozzles were 0.161 in. diam.)

Centrifugal water separators downstream from the Venturi scrubbers are required to remove the entrained scrubber water from the scrubbed gases. The gases from the Venturi enter the lower portion of the separator tangentially. The centrifugal force equal to 60 times gravity is designed to remove all entrained water particles exceeding 15$\mu$. The inlet velocity to this separator is 5,300 ft./min. The exhaust gases leaving this separator have never carried over water droplets to the atmosphere to the knowledge of the authors.

Although the Venturi scrubber is a relatively simple device and therefore maintenance and repair should be at a minimum, certain precautions are necessary. Examples of some operating and maintenance requirements, while probably peculiar to the particular application described here, may serve as a guide to possible pitfalls for any service to which the Venturi may be applied.

The exhaust gases partially consist of products of combustion. When fuel oil is used in the combustion, the sulfur inevitably present in fuel oils burns to sulfur dioxide which is then partially dissolved in the scrubber water. Extremely low $p$H and consequent corrosion will result. This condition can be obviated by either caustic injection for $p$H control or by handling the water once-through rather than by recycling the water and building up the acid concentration. When fuel gas is used the problem of low $p$H practically disappears.

Recycling the scrubber water is desirable in this day and age of chronic shortages of water for industrial uses. However, certain precautions are desirable. The solids, when allowed to build up to high concentrations in the recycled scrubber water, can constitute a nuisance by either agglomerating on the walls of the vessels or by clogging the scrubber water orifice nozzles in the Venturi throat.

If the scrubbed gases are hot, then the recycled water will approach a temperature equal to that of the gases. There is no evidence that the scrubbing efficiency as such is lowered by warmer water. However, in this particular case, cold water has the effect of condensing out of the exhaust gas additional small quantities of organic material which can contribute to the total odor level. Use of once-through water about 50° cooler than the recycled water results in about a 10% additional removal of odors for the exhaust under consideration.

Water is not the only liquid which can be used as a scrubbing medium. Use of a different liquid may facilitate the reuse of the atmospheric pollutant scrubbed out of the exhaust. For example, black liquor can be utilized for scrubbing the salt cake fume in the Kraft Paper process and fuel oil can be the scrubbing medium in removing oil vapors and fumes from certain emissions.

### Waste Disposal Problem?

Another point to consider long before a Venturi scrubber is installed is whether or not the elimination of an atmospheric pollution problem will result in a waste disposal problem. On the assumption that the gases are scrubbed clean, the scrubber water contains the particulate matter and must be disposed of. The quantity and nature of the solids will determine the degree, if any, of waste treatment required. This factor must be considered in comparing the economics of the Venturi scrubber to other methods of odor control such as tall stacks, catalytic furnaces, and carbon absorption units.

### Acknowledgment

Credit is due R. L. Kramer, W. E. Allen, D. R. Shern, V. E. Gex, F. F. Albert, E. H. Kendall, and others of the Procter & Gamble Company for their contributions in utilizing the Venturi scrubber in odor-control work.

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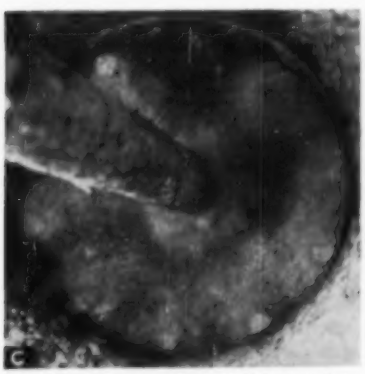


Fig. 11c. 5.38 gal./min./1,000 cu.ft./min. 40% center pipe, 60% peripheral nozzles.

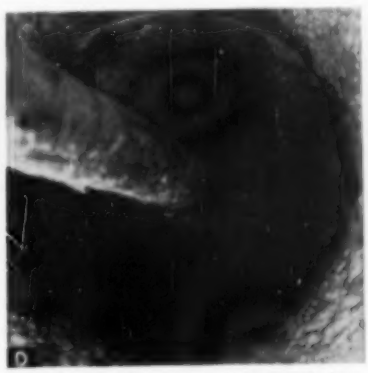


Fig. 11d. 2.15 gal./min./1,000 cu.ft./min. 50-50 water distribution.

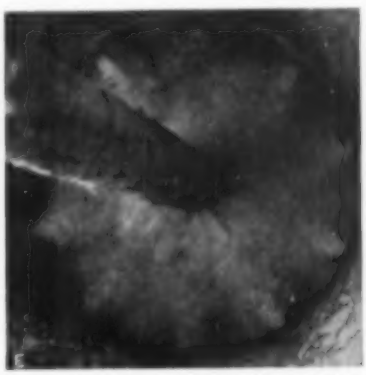


Fig. 11e. 13.5 gal./min./1,000 cu.ft./min. 50-50 water distribution.

## calculation of

# LIQUID-VAPOR EQUILIBRIUM CONSTANTS FROM SOLUBILITY DATA

Much confusion exists in the interpretation of the various methods used to express the solubility of a gas in a liquid solvent. In this article, the most frequently used solubility coefficents are defined and their limitations discussed. Examples are also given of how such data may be converted into the more useful liquid-vapor equilibrium constants and how they may be applied to multicomponent systems.

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Few liquid-vapor equilibrium constants are available for systems other than those of the low molecular weight hydrocarbons. When a designer needs an equilibrium constant such as for acetylene in acetone or argon in ammonia, he must calculate it from solubility data. This is difficult to do for the following reasons:

- A wide variety of forms of "solubility coefficients" are used in reporting these data. These differ with respect to the temperature, pressure, and partial pressure of the component whose solubility is being determined, not only for the solubility measurement itself, but for reporting the volume of gas dissolved. The conditions for standardizing both the solubility and the gas volume are not always clearly stated in the definition of the coefficients. Additional interpretation of the coefficients is required before the data can be used for liquid-vapor equilibrium calculations.

- Many investigators obtain data at a series of temperatures and total pressures which they duly record, but correct the solubility measurements by changing the amounts of gas absorbed at the different temperatures to a common partial pressure and/or expressing the results in volume units corrected to STP, or to some other condition.

  Such changes have been found to cause trouble either because no mention was made of the fact that the published results did not correspond to the recorded experimental pressure, or because, in adjusting from one pressure basis to another, no allowance was made for the partial pressure of a volatile solvent.

- For cases involving volatile solvents, investigators differ in the way that they consider experimentally the presence of the solvent above the liquid phase.

- Some solubilities are reported for a unit volume of solution instead of a unit volume of the pure solvent. This requires the use of the coefficient of dilatation by absorption.

- Many investigators are interested in the liquid phase compositions alone, apparently unaware that such data also have utility for liquid-vapor applications, and thus fail to report on the composition of the vapor above the liquid.

Aside from the five items listed above, which deal principally with bridging the gap between a solubility reported in the literature and the corresponding liquid-vapor equilibrium constant obtained from it, several other factors must be fully understood if such data are to be used to derive $K$ values at other conditions of temperature, pressure, or composition. Although many of the solubility data are at very dilute concentrations where Henry's law applies and at low pressures where the vapor phase is ideal, cases are also encountered where these simplifications cannot be employed. Furthermore, of approximately 100 systems studied, only one or two instances of an ideal solution were found where the activity coefficient was 1.0 and the $K = p/x$ relationship applied. Such assumptions can lead to liquid compositions which are in error by a factor of 50 to 1. If a constant activity coefficient is used beyond the Henry's law region, large errors will result. The fact that the concentration in the liquid is still relatively dilute does not affect this situation.

It is the purpose of this article to show how the various types of solubility data found in the literature can be converted into liquid-vapor equilibrium constants, and to show how such information can be extended to other temperatures, pressures and compositions, for the general case as well as where Henry's law applies.

A complete understanding of the various forms in which solubility data are reported is basic to this whole subject.

### Type of Solubility Data

The Bunsen coefficient, $\alpha$, is defined as the volume of gas, computed at 32° F. and 1 atm., dissolved at the reported experimental temperature by a unit volume of liquid when the gas has a partial pressure of 1 atm. in the vapor phase above the solution.

The Ostwald coefficient, $l$, as classically defined, is the volume of gas dissolved by a unit volume of *solvent* at a given temperature. In using this coefficient it is assumed that Henry's, Boyle's, and Dalton's laws hold, and therefore that the Ostwald coefficient is independent of the partial pressure of the gas above the solution. When it is known that these laws do not hold, such data should not be reported as "Ostwald coefficients," but simply as "solubility coefficients."

The Ostwald coefficient, as used by Horiuti (*3*), $\gamma_H$, is somewhat different. Because Horiuti reported so many of the data in this field, this coefficient warrants equal attention with $l$. This coefficient is the volume of gas dissolved at a given temperature by a unit volume of *solution*. It, too, is independent of partial pressure. By basing the value on the solution instead of the solvent, it is necessary to introduce the coefficient of dilatation by absorption, $\delta$, when computations with $\gamma_H$ are encountered.

Data are sometimes reported simply as "solubility coefficients." This general expression refers to the amount of gas, which may be in either weight or volume units, dissolved in a unit amount of solvent, which again may be in weight or volume units, at a specified temperature and a specified gas partial pressure or system total pressure. If the quantity of gas dissolved is reported in volume units,

such "solubility coefficients" may use any reference temperature and pressure for this volume. These data represent the particular investigator's idea of a coefficient.

### The Coefficient of Dilatation by Absorption

A discussion of the inter-relationships of $a$, $l$, and $\gamma_H$ involves the handling of the coefficient of dilatation by absorption ($\delta$). When a gas is dissolved by a liquid, the volume of the liquid phase increases. This increase per volume of gas absorbed, when the gas volume is at *STP*, gives the value of $\delta$.

$$\delta = \frac{(\text{cu.cm. solution} - \text{cu.cm. solvent})}{\text{cu.cm. gas } (STP)} \tag{1}$$

$$= \frac{\text{cu.cm. solution}}{\text{cu.cm. gas (STP)}} - \frac{\text{cu.cm. solvent}}{\text{cu.cm. gas } (STP)} \tag{1a}$$

but

$$a = \left[ \frac{\text{cu.cm. gas } (STP)}{\text{cu.cm. solvent}} \right]_{p'_i = 1 \text{ atm}} \tag{2}$$

$$\therefore \delta = \left[ \frac{\text{cu.cm. solution}}{\text{cu.cm. gas}(STP)} - \frac{1}{a} \right]_{p'_i = 1 \text{ atm}} \tag{3}$$

### The Bunsen and the Ostwald Coefficients

The Bunsen coefficient and both the Ostwald coefficients involve computations where Henry's law

$$p' = Hx_i \text{ (or, more strictly, } f_i = Hx_i) \tag{4}$$

and Dalton's law

$$\pi = p'_i + p'_j = y_i\pi + y_j\pi \tag{5}$$

both apply.

In working with the Ostwald coefficients it is particularly important to bear in mind the use of Henry's law. For example, whereas the Bunsen coefficient is based on the gas being at 1 atm. partial pressure and the volume being expressed on a 1-atm. basis, these specifications are not put on the Ostwald values. If pressure is increased in a series of runs for determining solubilities, more and more gas will be dissolved according to Henry's law, but by Boyle's law the volume will be inversely proportional to the pressure. The numerical value of the coefficient remains the same. It it for this reason that neither the gas volume reference pressure nor the partial pressure need be stated for an Ostwald coefficient. In working with it, 1 atm., or any other value consistent with the application of Henry's law, may be assumed for each.

However, when 1 atm. partial pressure and gas volume reference pressure are assumed for an Ostwald coefficient, it is obvious that the only real difference between $a$ and $l$ (but not $a$ and $\gamma_H$) is the temperature of reference for the gas volume; the Bunsen coefficient uses 32° F., whereas $l$ uses the experimental temperature, $t$.

Therefore the relationship between the Bunsen coefficient and the Ostwald coefficient is

$$a = \frac{492}{T} l \tag{6}$$

$$\frac{\text{cc gas (STP)}}{\text{cc solution}} = \left| \gamma_H \times \frac{492}{T} \right|_{p'_i = 1 \text{ atm}} \tag{9}$$

Substituting Equation (9) into Equation (3),

$$\delta = \left[ \frac{T}{492\gamma_H} - \frac{1}{a} \right]_{p'_i = 1 \text{ atm}} \tag{10}$$

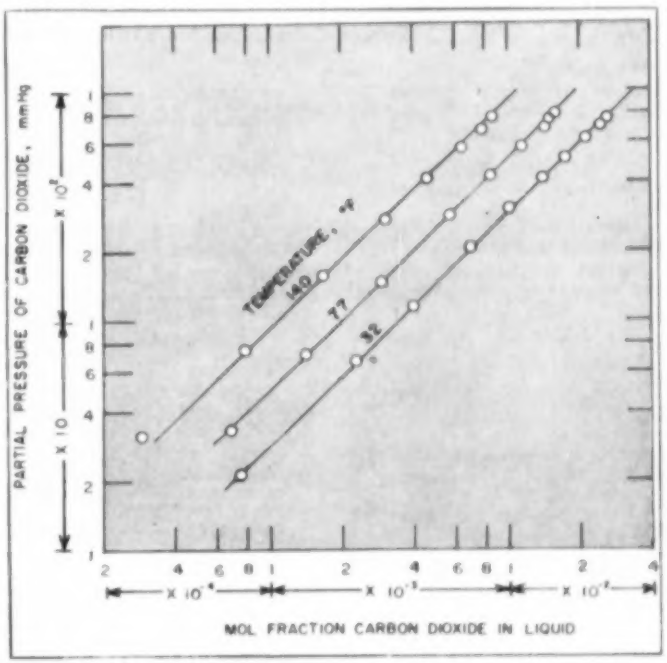



Fig. 1. Partial pressure of carbon dioxide in dimethyl formamide.

The relationship between the Bunsen and Horiuti "Ostwald coefficient" is derived as follows:

The Ostwald coefficient, $\gamma_H$, based on the unit volume of solution, is defined as:

$$\gamma_H = \frac{\text{cu.cm. at temperature, } t}{\text{cu.cm. solution}} \tag{7}$$

$$\text{At 32° F., } \frac{\text{cu.cm. gas (32° F.)}}{\text{cu.cm. solution}} = \gamma_H \times \frac{492}{T} \tag{8}$$

At 1 atm. partial pressure,

Solving for $a$:

$$a = \frac{492\gamma_H}{(T - 492\delta\gamma_H)} \tag{11}$$

Because $l = \frac{aT}{492}$ from Equation (6)

$$l = \frac{T\gamma_H}{(T - 492\delta\gamma_H)} \tag{12}$$

By the use of Equation (12) the Horiuti-type Ostwald coefficient, $\gamma_H$, can be converted into the conventional form, $l$. This is particularly useful in comparing the data published by Horiuti with other work.

Calculating the equilibrium constant $K$ directly from the Horiuti-type Ostwald coefficient becomes a rather complicated procedure unless the path of calculation is through the determination of the Bunsen coefficient by means of Equation (11). Frequently it is impossible to do otherwise because the experimenter may not record the partial pressure of the solute gas. In these instances it is not necessary to know the experimental partial pressure of the solute because it is not required when $K$'s are calculated from $\alpha$'s. Similar considerations apply to $l$. Therefore, for convenience, it is recommended that at all times the $K$-constant calculations be made by means of $\alpha$'s. Illustration 4A (below) will bring out this point.

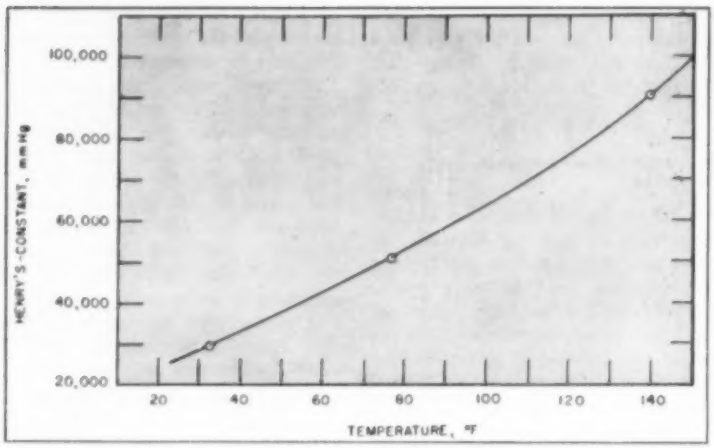



Fig. 2. Henry's Law constant for carbon dioxide in dimethyl formamide.

## Sample Calculations for Various Solubility Coefficients

In the following illustrative calculations the various solubility coefficients for acetylene in acetone at 77° F. are converted to $\alpha$'s for comparison.

***Illustration 1:***

The Ostwald coefficient, $l$, determined by Maillard and Rosenthal (*6*) at 77° F., is 21.0 cu.cm. acetylene per cu.cm. of acetone. What is the Bunsen coefficient?

$$\alpha = \frac{492}{T} l$$

$$\alpha = \frac{492}{537} \times 21.0 = \frac{19.2 \text{ cu.cm. acetylene}}{\text{cu.cm. acetone}}$$

By definition, the 19.2 cu.cm. of acetylene are at $STP$.

***Illustration 2:***

For acetylene in acetone Horiuti (*3*) reports an Ostwald coefficient, $\gamma_H$, of 22.00 cu.cm. solute per cu.cm. of solution at 77° F. The coefficient of dilatation by absorption is $2.163 \times 10^{-4}$ cu.cm. solution per cu.cm. gas at $STP$ (*3*). Calculate $l$ and $\alpha$.

$$l = \frac{T\gamma_H}{(T - 492\beta\gamma_H)}$$

$$= \frac{537 \times 22.00}{537 - 492(0.002163)(22.00)} = 23.0$$

$$\alpha = l \times \frac{492}{T} = 23 \times \frac{492}{537} = 21.0$$

***Illustration 3:***

A laboratory-measured solubility of acetylene in acetone at 77° F. and 1 atm. total pressure was expressed as 16.1 g. of acetylene per liter of solution instead of as a coefficient. Using the $\beta$ of Illustration 2 (above), calculate $\alpha$ for $C_2H_2$. The density and vapor pressure of acetone at 77° F. are 0.787 g./cu.cm. and 4.4 lb./sq.in.abs.

$$(a)\ \frac{\text{cu.cm. acetylene } (STP)}{\text{cu.cm. solution}} = \frac{16.1 \text{ g. acetylene}}{26.04 \text{ g./mol acetylene}} \times \frac{22{,}400 \text{ cu.cm. acetylene } (STP)}{\text{mol acetylene}} \Big/ 1{,}000 \text{ cu.cm. solution}$$

$$= \frac{13.8 \text{ cu.cm. } (STP)}{\text{cu.cm. solution}}$$

(*b*) Substituting into Equation 1a:

$$\beta = \frac{\text{cu.cm. solution}}{\text{cu.cm. gas } (STP)} - \frac{\text{cu.cm. solvent}}{\text{cu.cm. gas } (STP)}$$

$$0.002163 = \frac{1}{13.8} - \frac{1}{\text{cu.cm. gas } (STP)/\text{cu.cm solvent}}$$

$$\frac{\text{cu.cm. gas } (STP)}{\text{cu.cm. solvent}} = 14.3$$

(*c*) The mol fractions in the liquid are next calculated:

$$\text{Mols acetylene} = \frac{16.1}{26.04} = 0.62$$

$$\text{Mols acetone} = \frac{1{,}000 \text{ cu.cm.} \times 0.787 \text{ g./cu.cm.}}{58.08 \text{ g./mol}} = \frac{13.55}{14.17}$$

$$x_{\text{acetylene}} = \frac{0.62}{14.17} = 0.0437$$

$$x_{\text{acetone}} = 0.956$$

(*d*) By Raoult's law, applied to solvent $p'_{\text{acetone}} = 0.956 \times 4.4 = 4.2$ lb./sq.in.abs.

(*e*) Total pressure (given) = 14.7 lb./sq.in.abs.

(*f*) $p'_{\text{acetylene}} = 10.5$ lb./sq.in.abs.

(*g*) Calculation of $\alpha$:

(1) The solubility at an acetylene partial pressure of 10.5 lb./sq.in.abs. is from *Step* (*b*):

$$\frac{14.3 \text{ cu.cm. gas } (STP)}{\text{cu.cm. solvent}}$$

(2) From Henry's law, at 14.7 lb./sq.in.abs. this becomes:

$$14.3 \times \frac{14.7}{10.5} = \frac{20.0 \text{ cu.cm. acetylene } (STP)}{\text{cu.cm. solvent}}$$

This is the Bunsen coefficient, $\alpha$, at 77° F.

The data from the three sources have been converted to a common basis and can now be compared and their relative accuracy evaluated:

| Illustration | Investigator | $\alpha$ |
|---|---|---|
| 1 | Maillard and Rosenthal | 19.2 |
| 2 | Horiuti | 21.0 |
| 3 | Laboratory | 20.0 |

### Direct Calculation of $\alpha$ Liquid-Vapor Equilibrium Constant from $\alpha$ Bunsen Coefficient

$$\text{Bunsen coefficient, } \alpha = \left[\frac{\text{cu.cm. gas } (STP)}{\text{cu.cm. solvent}}\right]_{p'=1 \text{ atm.}}$$

$$\text{Mols of gas dissolved/cu.cm. solvent} = \frac{\alpha}{22{,}400}$$

$$\text{Mols of solvent/cu.cm. solvent} = \frac{1 \times \rho_L}{M}$$

$$\text{Mols gas/mol solvent} = \left(\frac{\alpha}{22{,}400}\right) \Big/ \left(\frac{\rho_L}{M}\right)$$

$$= \frac{aM}{22{,}400\rho_L} \quad (13)$$

Mol fraction gas in liquid

$$= \frac{\frac{aM}{22{,}400\rho_L}}{1 + \frac{aM}{22{,}400\rho_L}} = \frac{aM}{22{,}400\rho_L + aM} = x_i \quad (14)$$

Mol fraction solvent $= (1 - x_i)$ (15)

The partial pressure of solvent can be found by Raoult's law. (When Henry's law applies to a solute, Raoult's law applies to the solvent.)

$$p'_j = (1 - x_i)p_j \quad (16)$$

$$\pi = p'_i + p'_j = 14.7 + (1 - x_i)p_j \quad (17)$$

$$y_i = \frac{p'_i}{\pi} = \frac{14.7}{[14.7 + (1 - x_i)p_j]} \quad (18)$$

$$K_i = \frac{y_i}{x_i} = \frac{14.7/[14.7 + (1 - x_i)p_j]}{x_i} \quad (19)$$

***Illustration 4:***

At 104° F. Horiuti (*3*) measured the solubility of acetylene in acetone as 16.19 cu.cm. $C_2H_2$/cu.cm. of solution. Calculate the $K$ of $C_2H_2$ at the pressure of the experiment and also at atmospheric pressure. $\delta = 0.00265$. The vapor pressure and density of acetone at 104° F. are 8.0 lb./sq.in. and 0.770 g./cu.cm., respectively.

Solution:

Using Equation (11):

$$a = \frac{492\gamma_H}{(T - 492\delta\gamma_H)}$$

$$= \frac{(492)(16.19)}{[564 - (492)(0.00265)(16.19)]}$$

$$= 14.7$$

Using Equation (14):

$$x_i = \frac{aM}{22{,}400\rho_L + aM}$$

$$x_i = \frac{(14.7)(58.08)}{(22{,}400)(0.770) + (14.7)(58.08)}$$

$$= 0.0473$$

Using Equation (19):

$$K_i = \frac{14.7}{[14.7 + (1 - x_i)p_j]x_i}$$

$$= \frac{14.7}{[14.7 + (1 - 0.0473)8.0](0.0473)}$$

$$= 13.9$$

From Equation (17):

$\pi = 14.7 + (8.0 \times 0.9527) = 22.3$ lb./sq.in.abs.

$K$ at 14.7 lb./sq.in.abs. is also desired:

$$K = 13.9 \times \frac{22.3}{14.7} = 21.0$$

This same example is useful for demonstrating the error that can result when one is not completely familiar with these solubility coefficients. Horiuti describes his work as being conducted at a total pressure of 1 atm. Illustration 4 will be reworked accordingly:

***Illustration 4A:***

If $\pi$ is 14.7 lb./sq.in.abs., instead of $p'_i = 14.7$ lb./sq.in.abs., what is $K_i$ at 14.7 lb./sq.in.abs.?

$p'_i = [14.7 - (8.0)(0.9527)] = 7.1$ lb./sq.in.abs.

$$y_i = \frac{7.1}{14.7} = 0.483$$

$$K_i = \frac{y_i}{x_i} = \frac{0.483}{0.0473}$$

$= 10.2$ at $\pi = 14.7$ lb./sq.in.abs.

However, the calculation of $K$ for atmospheric pressure in Illustration 4 showed it to be 21.0, an error of

$$\frac{21.0 - 10.2}{21.0} \times 100 = 51.5\%!$$

This illustration may appear to contradict the previous assertion, in connection with the definition of an Ostwald coefficient, that any condition of partial pressure may be employed. However, the pressure of reference for the gas volume must be made numerically equal to this partial pressure to take advantage of the simultaneous application of the

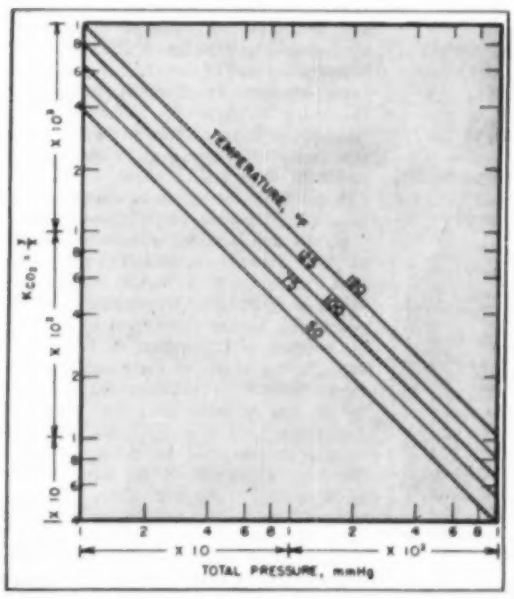



Fig. 3. Liquid-vapor equilibrium constants for carbon dioxide in dimethyl formamide.

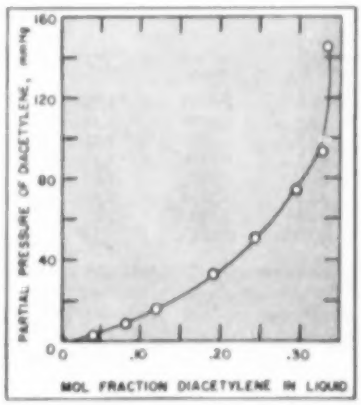



Fig. 4. Partial pressure of diacetylene in dimethyl formamide.

Fig. 5. Activity coefficients of diacetylene in dimethyl formamide.

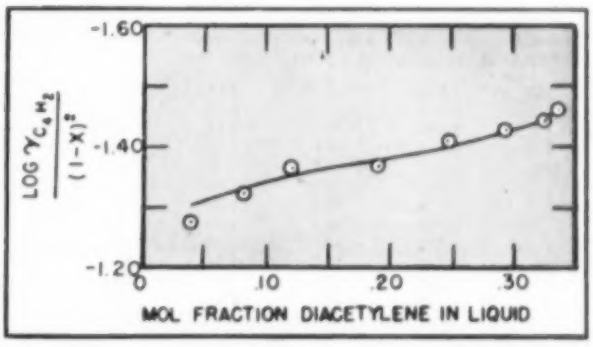


**Table 1.**

| 32° F. | | | 77° F. | | | 140° F. | | |
|---|---|---|---|---|---|---|---|---|
| $p'_{CO_2}$ mm. Hg. | S | $x_{CO_2}$ | $p'_{CO_2}$ mm. Hg. | S | $x_{CO_2}$ | $p'_{CO_2}$ mm. Hg. | S | $x_{CO_2}$ |
| 21 | 0.22 | 0.000741 | 33 | 0.20 | 0.000690 | 31 | 0.08 | 0.000286 |
| 66.5 | 0.68 | 0.00229 | 71 | 0.41 | 0.00142 | 75 | 0.22 | 0.000787 |
| 116 | 1.19 | 0.00401 | 145 | 0.85 | 0.00294 | 158.5 | 0.47 | 0.00168 |
| 204.5 | 2.10 | 0.00709 | 284 | 1.65 | 0.00570 | 274 | 0.85 | 0.00304 |
| 306 | 3.14 | 0.0106 | 428 | 2.48 | 0.00850 | 411.5 | 1.28 | 0.00458 |
| 411 | 4.22 | 0.0142 | 570 | 3.31 | 0.01145 | 568 | 1.76 | 0.00630 |
| 515 | 5.29 | 0.0178 | 697 | 4.16 | 0.0144 | 692 | 2.20 | 0.00787 |
| 614.5 | 6.34 | 0.0214 | 760 | 4.42 | 0.0153 | 760 | 2.40 | 0.00860 |
| 713 | 7.39 | 0.0249 | 783 | 4.55 | 0.0157 | 764 | 2.42 | 0.00866 |
| 760 | 7.88 | 0.0266 | | | | | | |

S = cu.cm. $CO_2$(STP)/cu.cm. DMF at temperature and $p'_{CO_2}$ given for each point.

**Table 2.**

| Solubility coefficient, S cu.cm. diacetylene (STP)/cu.cm. solution | Diacetylene partial pressure, mm. Hg |
|---|---|
| 12.22 | 3.5 |
| 26.34 | 8.5 |
| 40.30 | 14.5 |
| 69.60 | 32.5 |
| 95.16 | 51.5 |
| 121.50 | 75.5 |
| 138.73 | 93.5 |
| 145 | 100 |

**Table 4.**

| $x_{C_4H_2}$ | $p_{C_4H_2}$ At 77° F. mm. Hg | $\gamma$ From Figure 5 | $\gamma p_{C_4H_2}$ At 77° F. |
|---|---|---|---|
| 0.02 | 1,336 | 0.0608 | 81.2 |
| 0.05 | ↓ | 0.0688 | 92.0 |
| 0.10 | ↓ | 0.0835 | 111.2 |
| 0.15 | ↓ | 0.104 | 139 |
| 0.20 | ↓ | 0.127 | 170 |
| 0.25 | ↓ | 0.158 | 211 |
| 0.30 | ↓ | 0.199 | 266 |
| 0.35 | ↓ | 0.250 | 334 |

**Table 3.**

| $p'_{C_4H_2}$ mm. Hg | $x_{C_4H_2}$ | $p'_{DMF}$ mm. Hg | $\pi$ mm. Hg | $y_{C_4H_2}$ | $K_{C_4H_2}$ | $\gamma_{C_4H_2}$ |
|---|---|---|---|---|---|---|
| 3.5 | 0.0400 | 3.70 | 7.2 | 0.486 | 12.15 | 0.0655 |
| 8.5 | 0.0824 | 3.53 | 12.03 | 0.709 | 8.62 | 0.0775 |
| 14.5 | 0.1207 | 3.38 | 17.88 | 0.814 | 6.74 | 0.090 |
| 32.5 | 0.1918 | 3.11 | 35.6 | 0.914 | 4.76 | 0.127 |
| 51.5 | 0.245 | 2.90 | 54.4 | 0.946 | 3.88 | 0.158 |
| 75.5 | 0.2929 | 2.72 | 78.2 | 0.965 | 3.30 | 0.193 |
| 93.5 | 0.322 | 2.61 | 96.1 | 0.972 | 3.04 | 0.218 |
| 100 | 0.334 | 2.56 | 102.6 | 0.975 | 2.92 | 0.224 |

**Table 5.**

| Total pressure, lb./sq.in.abs. | $H_2$ in liquid, mol per cent | $H_2$ in vapor, mol per cent | Experimental K's |
|---|---|---|---|
| 1,235 | 1.84 | 98.01 | $\therefore K_{H_2} = 53.3$ |
| 1,780 | 2.56 | 98.45 | $\therefore K_{H_2} = 38.4$ |
| 11,800 | 13.86 | 99.39 | $\therefore K_{H_2} = 6.4$ |

**Table 6.**

| Temp., ° F. | Total pressure, lb./sq.in.abs. | Solubility of hydrogen, std. cu.cm./g. $CH_3OH$ | Hydrogen in liquid, calculated mol % | Hydrogen in vapor, measured mol % | Hydrogen in vapor, calculated mol % | $K_{H_2}$ Calculated |
|---|---|---|---|---|---|---|
| 70 | 1,118 | 8.11 | 1.145 | .... | ~100 | 87.4 |
| | 2,620 | 19.5 | 2.72 | .... | ~100 | 36.8 |
| | 2,630 | 19.7 | 2.75 | .... | ~100 | 36.4 |
| | 4,000 | 29.7 | 4.07 | .... | ~100 | 24.6 |
| 194 | 1,042 | 11.1 | 1.57 | .... | 96.3 | 61.3 |
| | 1,090 | 11.7 | 1.67 | .... | 96.8 | 58.8 |
| | 1,970 | 20.6 | 2.86 | .... | 98.2 | 34.4 |
| | 2,740 | 29.2 | 4.00 | .... | 98.8 | 24.6 |
| | 4,410 | 46.5 | 6.24 | .... | 99.0 | 15.8 |
| 284 | 1,148 | 16.0 | 2.24 | 89.0 | 86.1 | 38.5 |
| | 2,880 | 39.9 | 5.90 | 95.3 | 94.4 | 17.5 |
| | 4,130 | 57.7 | 7.46 | 96.6 | 96.1 | 12.6 |

Henry and Boyle laws, fundamental to all Ostwald coefficient calculations, as explained above ("The Bunsen and the Ostwald Coefficients"). In Illustration 4A it will be noted that these values were not equal, being 14.7 and 7.1, respectively.

Mere examination of Horiuti's data in this case, without prior experience with these coefficients, would lead to much too low a $K$ value. The fact that the measured solubilities were adjusted before being published in the table of results is nowhere mentioned. The conclusion is that a full understanding of the various coefficients is required to overcome deficiencies in work published by those who are not aware of the full extent to which it can be applied.

The more volatile the solvent, and therefore also the higher the temperature, the greater will be the error in interchanging total and partial pressure.

Misapplication of the $K = p/\pi$ relationship in this case would give a $K$ of 64 at 14.7 lb./sq.in.abs. and a temperature of 104° F. where the vapor pressure of acetylene is 940 lb./sq.in.abs. by slight extrapolation above the critical point:

$$K_i = \frac{p_i}{\pi} = \frac{940}{14.7} = 64$$

The correct $K$ from Illustration 4 is 21.0. The error here lies in the fact that the "$p/\pi$ rule" assumes ideal solutions where $\gamma$ is 1.0. These very dilute solute cases, where Bunsen and Ostwald solubility coefficients are used, are seldom ideal.

### Calculation of *K*-Constants for a System Over a Range of Temperatures, Pressures and Concentrations

Rarely are the solubility data in the range of temperatures, pressures and concentrations at which the $K$-constants are desired. When the data are in the form of solubility coefficients they are usually at a constant partial pressure, and therefore the value given at each temperature will be at a different total pressure because of the change in solvent vapor pressure. On the other hand, it is customary to carry out $K$-constant calculations at constant *total* pressure. It is expedient, therefore, to convert the solubility data into a chart which will give the $K$ of the solute at *any* temperature, total pressure and concentration.

If the data are in the form of either of the Ostwald coefficients, they can first be converted to Bunsen coefficients, as we have already recommended, before proceeding to the calculation of $K$'s by the method of Illustration 4. When the data are not in one of these standardized forms, instead of grinding out the $K$'s by the use of ready-made formulas like Equations (14) and (19), the $K$'s can usually be computed by using the relationships which led to the development of Equations (14) and (19). Illustrations 5 and 6, which follow, are examples of such cases.

Once the $K$-constants are obtained for each of the experimental points, a chart

for the desired range of temperatures, pressures and concentrations may be constructed. This step applies when $K$'s are desired from $x - y$ data and its coverage might be considered external to a discussion of the conversion of solubility data. Nevertheless, because such charts are the most useful manner of presenting data, and because little on this subject has been published, two illustrations are given below:

**1. The special case where Henry's law applies.**

**2. The general case where $K$ is a function of concentration at any temperature and pressure.**

It might be pointed out that for binary systems, to which the discussion has so far been limited, concentration cannot vary for a given temperature and pressure. However, in practice, multicomponent rather than binary systems are encountered in using $K$-constants, so that it is desirable to develop a chart over a range of concentrations. In so doing it is assumed that the presence of the other components will not affect the $K$'s derived from the binary system. As Lewis and Randall (5) point out, this is thermodynamically sound for the case of dilute solutions—the region which is nearly always present when data are reported in solubility form.

The effect of concentration on $K$-constants can be expressed by the equation

$$K_i = \gamma_i \frac{f_{iL}^{\circ}}{f_{iV}^{\circ}} \qquad (20)$$

Its use is demonstrated in Illustration 6. The correction for composition has been discussed by Carlson and Colburn (1), and others.

***Illustration 5:***

The solubility of carbon dioxide in dimethyl formamide (DMF) has been observed (2) at 32°, 77° and 140° F. From these data, determine the $K$-constant at 100° F. and 400 mm. Hg abs. Develop a $K$-constant chart for the range of the data (Table 1).

Solution:

1. The values of $x_{CO_2}$ shown in Table 1 are computed from the solubility coefficients. For example, at 32° F. for a $p'_{CO_2}$ of 21 mm. Hg, where $s = 0.22$:

$$\text{Mols } CO_2 \text{ dissolved/cu.cm. DMF} = \frac{s}{22{,}400} = \frac{0.22}{22{,}400}$$

$$\text{Mols DMF/cu.cm.DMF} = \frac{1 \times \rho_L}{M} = \frac{1 \times 0.9675}{73.09}$$

$$\text{Mols } CO_2\text{/mol DMF} = 0.000741$$

$$\text{Thus, } x_{CO_2} = 0.000741/(1 + 0.000741) \cong 0.000741$$

2. The values of $p'_{CO_2}$ and $x_{CO_2}$ are plotted in Figure 1. From the 45 deg. straight lines obtained it is evident that Henry's law holds. The Henry constant:

$$H_{CO_2} \equiv \frac{p'_{CO_2}}{x_{CO_2}}$$

is found for each temperature:

| $t$, °F. | $H$, mm.Hg. |
|---|---|
| 32 | 29,300 |
| 77 | 50,060 |
| 140 | 90,940 |

3. These are plotted in Figure 2 so as to obtain $H$'s at intermediate temperatures.

4. In the region where Henry's law applies, the general expression for a $K$-constant reduces to:

$$K_i = \frac{H_i}{\pi} \qquad (21)$$

and is independent of concentration (8).

5. Using Figure 2 and Equation (21), the $K$ of $CO_2$ in DMF at 400 mm. Hg and 100° F. is

$$K = \frac{63{,}200}{400} = 158$$

6. By similar calculations Figure 3 is constructed.

***Illustration 6:***

The solubility data listed in Table 2 were observed (2) for diacetylene in the solvent dimethyl formamide at 77° F. The vapor pressures of diacetylene and dimethyl formamide (DMF) at 77° F. are, respectively, 1,336 and 3.85 mm. Hg. The density of DMF is 0.942 at 77° F.; its molecular weight is 73.09.

Determine: the $K$-constants for $C_4H_2$ over a wide range of concentrations of $C_4H_2$ in the liquid beyond the limits of the Henry's law region for pressures up to 100 mm. Hg.

Solution:

1. By use of the method shown in the preceding illustration, the solubility coefficients are converted into values of $x_{C_4H_2}$. Applying Raoult's law, $p'_{DMF}$'s are computed and $\pi$ is obtained by adding the partial pressure of solute and solvent. $\gamma_{C_4H_2}$ and $K_{C_4H_2}$ are computed in the manner previously described (Table 3).

2. The activity coefficients, $\gamma_{C_4H_2}$, using liquid $C_4H_2$ in the pure state as the standard state, can be calculated by Equation (20):

$$K_{C_4H_2} = \gamma_{C_4H_2} \frac{(f_L)^{\circ}_{C_4H_2}}{(f_V)^{\circ}_{C_4H_2}}$$

At the low pressures involved, $(f_V)^{\circ}_{C_4H_2} = \pi$. It will be assumed that $(f_L)^{\circ}_{C_4H_2} = p_{C_4H_2}$ to simplify the calculation.

$$\therefore K_{C_4H_2} = \gamma_{C_4H_2} \frac{p_{C_4H_2}}{\pi} \qquad (22)$$

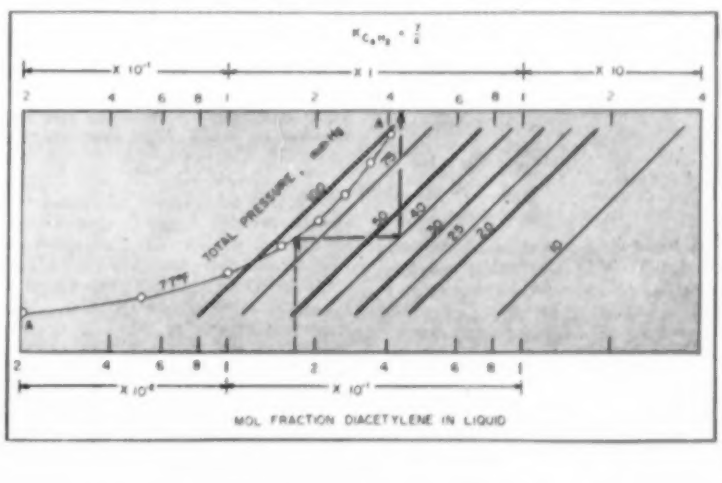
Values of $\gamma_{C_4H_2}$ so obtained are given in Table 3. The fact that $\gamma$ is not a constant indicates that Henry's law does not hold for this range of $C_4H_2$ concentrations. (See Figure 4.) The relation between $\gamma$ and $x$ can be plotted as $[\log \gamma/(1-x)^8]$ versus $x$, as shown in Figure 5.

3. Because $\gamma$ is a function of temperature, and in this case is also a function of concentration, temperature lines on the $K$ chart must take concentration into consideration. It will be found expedient first to plot $(\gamma p_{C_4H_2})$ versus $x_{C_4H_2}$ to obtain the various temperature lines (restricted to 77° F. in this example for brevity—see Table 4.) The values in the last column of Table 4 are plotted as the 77° F. line (A-A) in Figure 6.

4. The pressure lines for 10, 50 and 100 mm. Hg are now added to the plot by using Equation (22).

This example again points out the error in the use of the "$p/\pi$ rule" to obtain $K$. Whereas the $\gamma$'s calculated in Table 3 were from 0.0655 to 0.224, use of this rule is equivalent to using a $\gamma$ of

Fig. 6. Liquid-vapor equilibrium constants for diacetylene in dimethyl formamide.



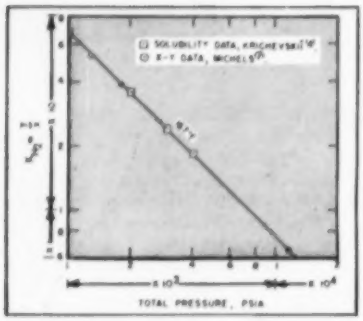



Fig. 7. Liquid-vapor equilibrium constants for hydrogen in methanol.

1.0, resulting in values of $K$'s too high by a factor of 15 to 4, respectively.

### Substantiation of K-Constants Calculated from Solubility Data

The accuracy of the calculated $K$-constants based on solubility data can be checked by comparison with $K$'s obtained from liquid-vapor equilibrium data. For the system hydrogen-methanol, $x - y$ data were measured by Michels *et al* (*7*) and solubility data were determined by Krichevskii *et al* (*4*).

At 167° F. Michels *et al* report the data shown in Table 5. These $K$'s are plotted in Figure 7.

The $K$'s from the solubility data of Krichevskii *et al*, given in Table 6, were first plotted versus $\pi$ with isothermal lines for 70°, 194° and 284° F., and then cross-plotted to get the 167° F. values. The good agreement between the calculated and experimental values is seen in Figure 7. Additional verification of the accuracy of this calculation method is given by the 284° F. runs of Krichevskii where experimental vapor compositions are given.

### Notation

$f$ = fugacity
$H$ = Henry's law constant, expressed in pressure units
$K$ = the liquid-vapor equilibrium ratio
$l$ = the Ostwald coefficient
$M$ = molecular weight of solvent
$p$ = vapor pressure
$p'$ = partial pressure.
$STP$ = standard temperature and pressure, 32° F. and 1 atm.
$S$ = solubility coefficient in general
$T$ = absolute temperature, ° R.
$t$ = temperature, ° F.
$x$ = mol fraction of component in the liquid
$y$ = mol fraction of component in the vapor

### Greek:

$\alpha$ = the Bunsen coefficient
$\gamma$ = liquid phase activity coefficient
$\gamma_H$ = the Ostwald coefficient employed by Horiuti (3)
$\delta$ = coefficient of dilatation by absorption
$\pi$ = total pressure
$\rho_L$ = density of solvent

### Subscripts:

$i$ = solute component in the solution
$j$ = solvent component in the solution
$L$ = liquid phase
$V$ = vapor phase

### Superscript:

° = standard state

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# WHAT'S IN SYMPOSIUM SERIES VOLUME 53

*(Number 20, 1957—Liquid Metals Technology*—Part 1)*

*Editor's Note:*

**Chemical Engineering Progress Symposium Series No. 19, 1956, Vol. 52 Nuclear Engineering—Part IV continues the publication of papers on the peaceful applications of nuclear energy begun with numbers 11, 12, and 13 of the series (see *Chemical Engineering Progress* Index, 1954). No. 19 contains most of the papers sponsored by the American Institute of Chemical Engineers for presentation at the Nuclear Engineering and Science Congress held in Cleveland in 1955. Space does not permit the abstracting of the more than twenty-five papers included in this volume. This will explain why No. 20 follows No. 18 in the series.**

### Low-cost Materials for Sodium Heat Transfer Systems

*E. G. Brush and R. F. Koenig*

Results of static and dynamic corrosion tests indicate that the carbon and low-alloy steels possess adequate resistance to attack in sodium up to 1,000° F. for most applications of heat transfer systems. Mass transfer is the only apparent significant difficulty which remains to be overcome. The potential savings through the use of low-alloy steels such as 2¼% Cr are great enough to justify the expenditure of considerable effort on the development of methods of controlling mass transfer or harmlessly removing excess solute from the system. Once this problem, which does not appear insurmountable from the work done so far, has been eliminated, the cost of sodium-cooled nuclear power plants can be reduced appreciably.

### Static and Dynamic Corrosion and Mass Transfer in Liquid Metal Systems

*Leo F. Epstein*

This is a brief survey of solution corrosion, which suggests that accurate qualitative models of the underlying fundamental phenomena are available and that order-of-magnitude calculation of corrosion rates is now possible. Many important aspects of the field have not been discussed in detail here, such as welding and diffusion bonding, carburization and nitridification, radioactive mass transfer in nuclear power systems, and the corrosion of compounds and non-metallic elements. They have been unemphasized not because they are of negligible importance but rather have these subjects been omitted for the sake of presenting a clear-cut picture of one aspect of liquid-metal-systems behavior rather than a comprehensive survey of the field.

### Control of Oxygen in Sodium Heat Transfer Systems

*I. L. Gray, R. L. Neal, and B. G. Voorhees*

This paper discusses briefly, both as to acceleration of corrosion and contribution to system plugging, the importance of oxygen as an impurity in sodium systems.

The plugging indicator, which determines the oxygen-saturation temperature of a flowing sodium system, is discussed, including descriptions of several typical installations, methods of operation, and precision for oxygen determination.

* $4.25 to non-members; $3.25 to members; 115 pages. Obtainable from offices of A.I.Ch.E. New York.

## CORRECTION

In "Nonwoven Filter Media" (July, 1957, p. 313) by Arthur C. Wrotnowski, an interchange of two figures is necessary for a correct interpretation of the article. On page 316, caption "Fig. 7" should be interchanged with caption "Fig. 9" on page 317.




## Quick Rundown on Raschig Rings:



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And there are new developments in Raschig Rings, too. In ceramics, the porcelain bodies are stronger, more resistant to spalling, possess better thermal shock properties. We have special bodies for better performance with alkalies. We make them in larger sizes, even up to six inches. And, of course, our porcelain bodies are completely iron-free, and show zero-absorption.

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## LONG TERM STRATEGIC GOAL IN SIGHT— NATURAL RUBBER SEEN AS NON-ESSENTIAL

**New development in butyl tire technology claimed to eliminate natural rubber completely in manufacture of large size military truck tires.**

Important savings in the defense program, and complete independence from imports of natural rubber, are seen as the two major results of a technical breakthrough recently announced by the Department of the Army. Claimed is the production of all-synthetic, heavy duty truck tires, first to pass the Army's rigid performance tests. Another advantage is almost complete freedom from ozone cracking and deterioration in standby storage, a factor responsible for millions of dollars spent in replacement.

The research work leading to the new development was a cooperative effort on the part of the Pennsylvania Tire Co. of Mansfield, Ohio, the Esso Research and Development Co., and the Army Ordnance Research and Development Center in Centerline, Michigan.

Butyl is not the only entry in the race for the enormous tire market. Firestone, with their "Coral" rubber, Goodrich-Gulf with their synthetic "natural" rubber, General Tire & Rubber with their newly-announced polyurethane rubber, Genthane "S," are definitely still in the running.

Comparative economics are anybody's guess at this writing. While butyl is cheap and plentiful (today's market price—23 cents a pound), no figures have been made public on the cost of the tire-making process. Firestone and Goodrich-Gulf, still in the pilot plant stage with their materials, decline to comment on the possible market price of their respective synthetic rubbers.

### Bonding the Key

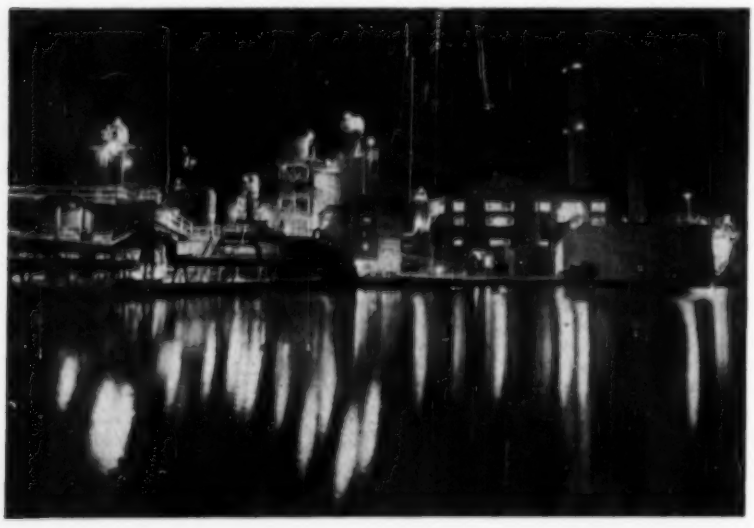
Butyl, invented by Esso Research scientists, dates back to 1937, is made at 150° F. below zero by a process called "ionic polymerization." Main ingredients are two oil refinery products—isobutylene and isoprene. Butyl is presently being produced in three plants in the U. S. and Canada: Esso's Baton Rouge refinery, the Baytown, Texas plant of Humble Oil and Refining, and the Polymer Corp. plant at Sarnia, Canada. Material for the present research program was supplied by Esso.

Raw material for the tire-making process is a standard commercial grade of butyl; the key to the successful new development was the discovery of how to bond the butyl with tire cord. The trick is turned with a butyl latex dip, making possible the use of conventional tire-making machinery. Tires thus far produced and tested are 9.00 by 20—the most widely used type in the Army. However, a program is stated to be currently under way to develop tires in the 14.00 by 20 and the 24.00 by 25 earthmover types.

### Too Much Ozone

Atmospheric ozone, tire killer number one, is on the increase in the United States, particularly in urban areas. Explanations differ. Most probable seems to be the photochemical reaction of sunlight with atmospheric contaminants. Exhausts from motor vehicles are thought by many to be a major contributor.

Butyl, with its almost complete immunity to ozone penetration, would seem to be in an advantageous position in this respect. All mass-produced tires are today being made of GRS (general purpose) synthetic rubber and natural rubber, or of 100 per cent natural rubber. Deterioration in storage is said to take place in as little as two or three months in some cases.



Substantial increase in refractory and magnesia capacity has resulted from a $3 million expansion program carried out by Kaiser Chemicals Division of Kaiser Aluminum & Chemical Corp. Key element in the expansion was doubling of seawater handling capacity at the company's Moss Landing, Calif., seawater magnesia plant where daily kiln capacity is now approximately 375 tons per day. In picture at left, plant is seen across one of the giant thickener tanks.

## MONTECATINI READY TO BUILD POLYPROPYLENE PLANT IN U.S.? NO! SAYS COMPANY

**Contrary to rumors, Montecatini has made no decision of any kind concerning the construction of any plant in the U. S.**

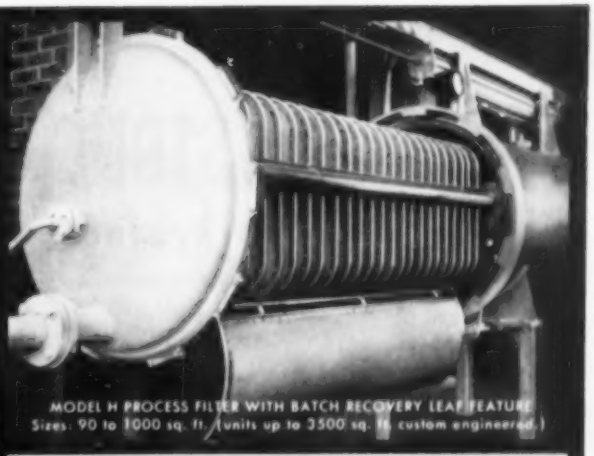
"Highly exaggerated," was the comment of Montecatini's New York representative when *CEP* queried him to check on the much publicized report that the giant Italian chemical firm was about to build a polypropylene plant in the United States.

The rumor concerning the alleged polypropylene plant evidently mushroomed from the fact that the Italian company has secured an option on an industrial site in West Virginia.

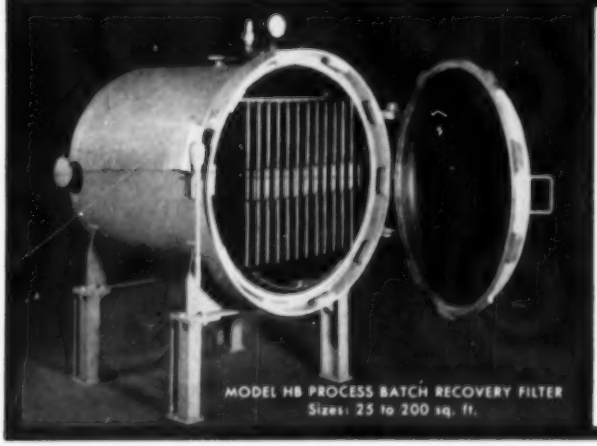
In answer to *CEP's* questions, the Montecatini spokesman indicated that "No decision whatsoever has been made to build a plant on the site for polypropylene or anything else, and none is likely before sometime in 1958. Even then, there is no direct evidence that it is polypropylene manufacture that might be considered for the site."

**A proposed merger of Dow Chemical and The Dobeckmun Co. of Cleveland has been approved** by the directors of the companies. Dobeckmun stockholders will vote this month. Dobeckmun is a producer of flexible packaging, gift wraps and metallic yarns. □

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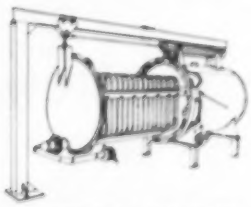
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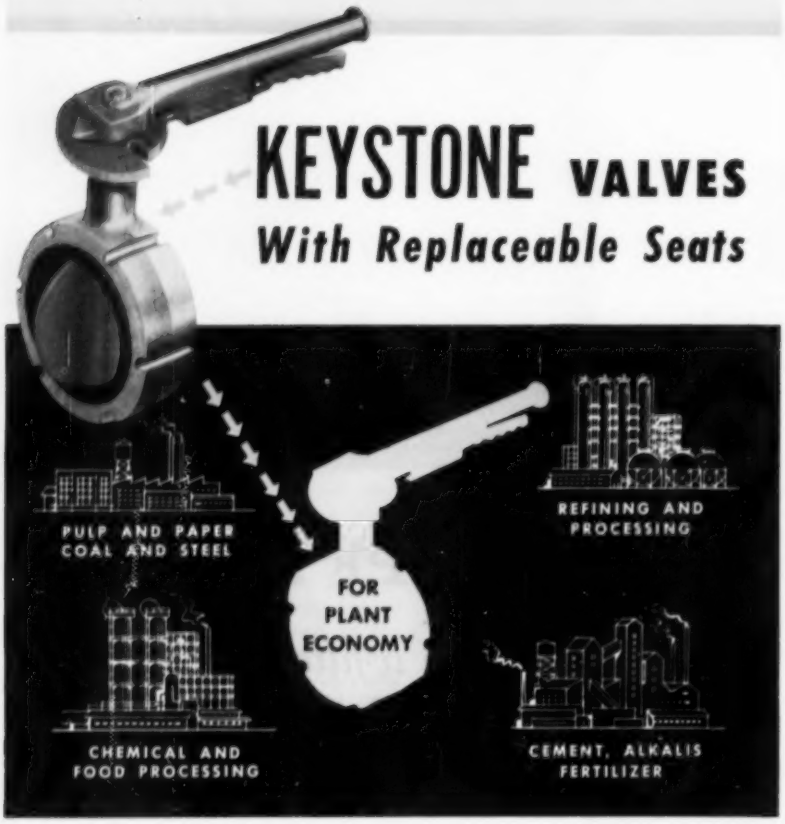
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## INDUSTRIAL NEWS

**Urea production is now underway at Spencer Chemical's Vicksburg, Miss., works.** To be produced for the first time at Vicksburg Works, the urea capacity is small—only 10,000 tons a year. Process being used was licensed from Montecatini, Italy. □

**Capacity of its vinyl chloride monomer operation** at Moundsville, W. Va., will be doubled by Solvay Process Division (Allied). □

**Boron trichloride, until recently available only in limited quantities, is now being produced and sold in tank car tonnages** by Stauffer Chemical Co. Used mainly in the manufacture of high energy fuels, significant price reductions have been made for the product since Stauffer brought larger facilities on-stream. Now one hundred-pound cylinders are $1.70 a pound (were $3.00 a pound); ton cylinders are $1.25 a pound; tank car lots are priced on a contract schedule. □

**Northam Electronics, Inc., is the new name of North American Instruments Co.** The company is a subsidiary of Norris-Thermador Corp., has headquarters in Los Angeles. □

**A $3,200,000 modernization and expansion program has been launched at three silicon carbide plants of The Carborundum Co.** The project will increase the combined capacity of the three plants some 25%. In addition to the expansion aspects of the project, extensive engineering work has been done on modernization which will provide new and improved methods of production. □

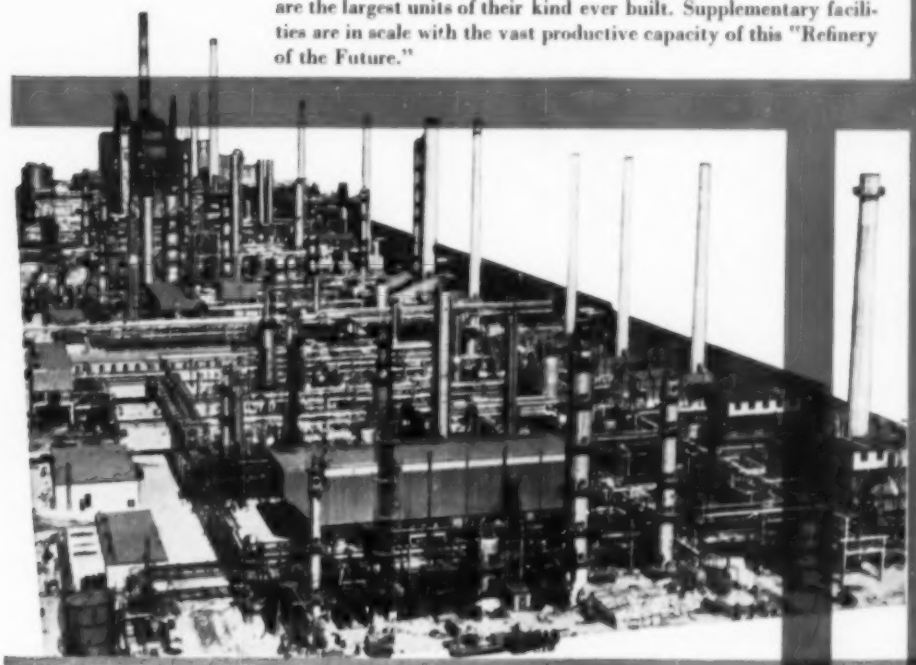
**Two subsidiaries of Union Oil Co. of California have merged** into one company. Brea Chemicals and R. T. Collier Corp. have joined and will be known as the Collier Carbon and Chemical Corp. □

**Sun Chemical has contracted to buy the Bensing Bros. & Deeney Companies** which will continue to operate under their own name but as a division of Sun Chemical. □

**Contract for the design and construction of a 150 ton a day nitric acid plant at the Yazoo City, Miss.** facilities of Mississippi Chemical Corp. has been awarded to The Chemical and Industrial Corp., Cincinnati, Ohio. This will be the fifth nitric acid unit of the high pressure design installed by C & I for Mississippi Chemical. □

# TIDEWATER—builds for the future

Tidewater Oil Company's new refinery near Wilmington, Delaware, is the largest refinery ever built as a single project. It has a total capacity of 130,000 barrels per day. Its crude unit, Orthoflow fluid catalytic cracking unit, fluid coker and 45,000 BPD Houdriformer are the largest units of their kind ever built. Supplementary facilities are in scale with the vast productive capacity of this "Refinery of the Future."



## CATALYTIC—maintenance for the future

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## INDUSTRIAL NEWS

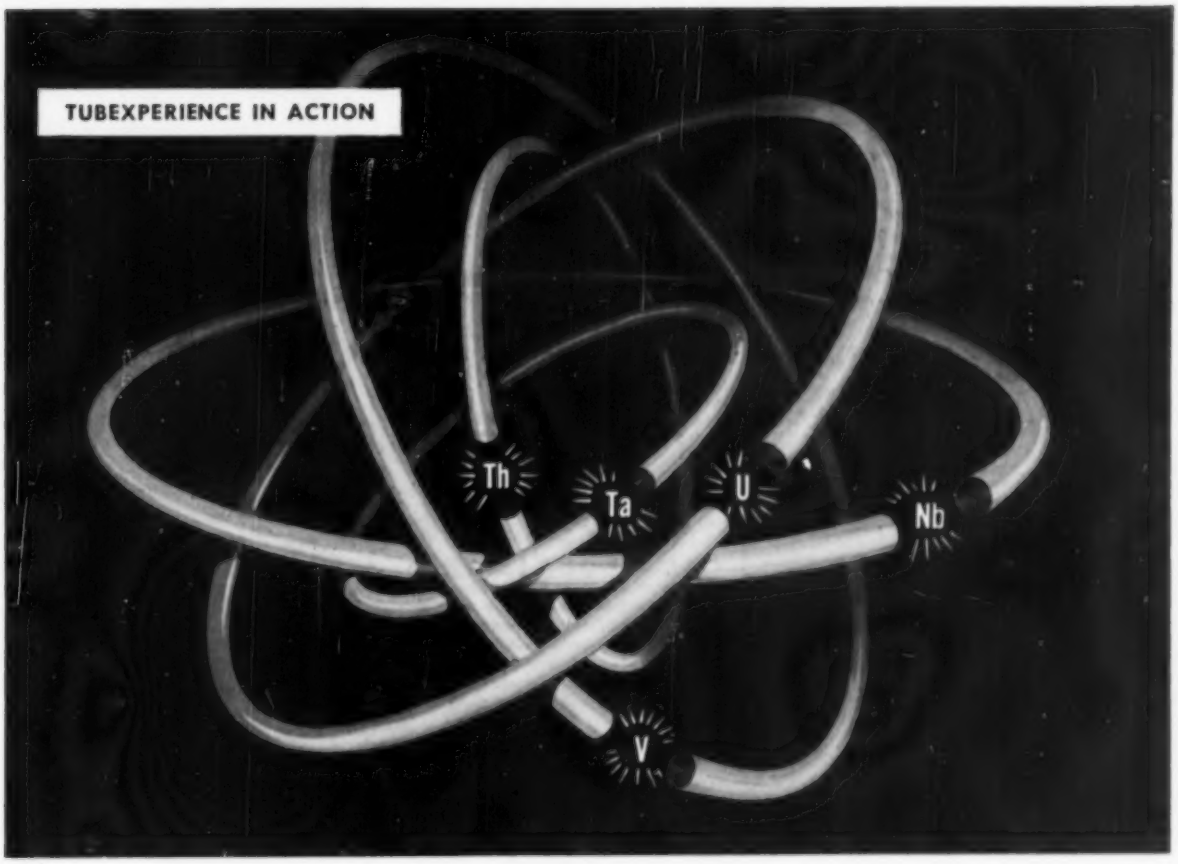
**Industrial chemicals from sugar as the major raw material** will be produced by the newly formed Sucrochemical Division of Colonial Sugars Co. a subsidiary of The Cuban-American Sugar Co. A pilot plant is already producing sucrose esters at the company's Gramercy, La., plant, including sucrose monostearate, sucrose monopalmitate, sucrose mono-oleate, sucrose monomyristate, and sucrose monolaurate. Sucrose esters are made by chemically reacting sucrose with methyl esters of fatty acids. Patent applications covering the process have been filed by Sugar Research Foundation which has given Cuban-American a non-exclusive license to use the process. □

**The $18 million borax production plant of Pacific Coast Borax Co.,** a division of United States Borax & Chemical Corp., is nearing completion at Boron, Cal. The plant facilities, which cover 80 acres in the Mojave Desert, are an engineering, designing and construction joint venture of SWECO-Twaits (Southwestern Engineering Co. and Twaits-Wittenberg Co.). Boron for high energy fuels is one of several products that will be processed at the plant. □

**Annual production of synthetic rubber by American Synthetic Rubber Co. will be increased by 25,000 long tons** by the recently completed $3.5 million expansion of the company's Louisville, Ky. plant. Design, procurement, and construction of the new facilities was done by Walter Kidde Constructors' Southwest Division. □

**Facilities for the production of emulsifiable polyethylene have been greatly expanded at the Buffalo, N. Y., plant of Semet-Solvay Petrochemical Division (Allied). Designated as Emulsifiable A-C Polyethylene 629, the special grade of polyethylene has been in growing demand for polishes, textile and paper sizing, building materials, etc., and the Semet-Solvay expansion is the result of the growing market.**






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### PROOF:

- *Superior has supplied millions of feet of tubing for atomic applications to many of the key manufacturers in the atomic field.*
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The end uses for Superior tubing in atomic energy include control rod tubing, fuel element tubing, tubing for moderator and shielding cans, process lines for handling radioactive liquids, and tubing for handling facilities.

**NOTE:** In some cases, tubing can be produced only with AEC release, because of priorities on materials.

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**SEND FOR LATEST DATA ON ZIRCONIUM**—*Write for your free copy of Special Analysis Memo 112—on zirconium, covering properties, fabrication and other data.*

# *Superior Tube*

**The big name in small tubing**

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A simple, economical and efficient method of restoring contaminated lubricating and sealing oil to the full value of new oil. HILCO Oil Reclaimers are used for the purification of vacuum pump oil in conjunction with the manufacture of transformers, condensers, capacitors, drugs, vitamin concentrates, radio tubes and light bulbs, essential oils, optical lenses, refrigeration compressors, titanium and many other products. A HILCO will produce and maintain oil free of all solids, sludge, acid, moisture, solvents, and dissolved gasses and restore viscosity, dielectric strength and other specifications to new oil value.

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- Continuous, all electric, automatic operation.
- Low operating temperature.
- Vacuum processing.
- Infrequent operation—low operating costs.



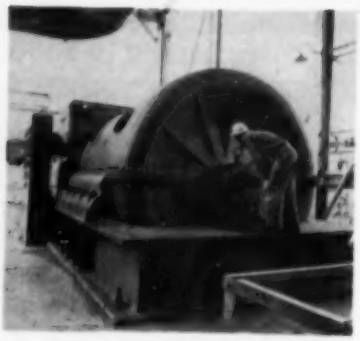
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## INDUSTRIAL NEWS



On-stream at the Ashland Oil & Refining Co. plant in Ashland, Ky. is the largest UOP catalytic cracker ever built. For this giant unit, De Laval Steam Turbine Co. built this centrifugal compressor which delivers 83,000 cu.ft./min. of air at 47.4 lbs./sq.in. absolute.

**Hexadecanol (cetyl alcohol), successfully used last year to reduce water-evaporation from reservoirs in Australia, will be tried by the Dept. of the Interior's Bureau of Reclamation** in a large scale test at Rattlesnake Reservoir near Loveland, Colo. Applied in a thin coating to the water surface, hexadecanol has eliminated more than 66% of evaporation losses in laboratory experiments, eliminated 20-70% evaporation in the Australian tests. As much as 65% of the nation's water could be saved if the tests are successful. □

**A new Canadian company, Witco Chemical Co., Canada, Ltd.,** has been formed by Witco Chemical Co., N. Y. Headquarters will be in Toronto, plant will be built in Trafalgar Township southwest of Toronto. □

**Minneapolis-Honeywell, 60% owner of the Datamatic Corp., has bought the other 40% of Datamatic from Raytheon Mfg. Co. for $4.5 million.** Datamatic, organized jointly by Minneapolis-Honeywell and Raytheon, is now wholly-owned by Minneapolis-Honeywell. Reason for the sale by Raytheon: rapid and extensive expansion of its own products made such demands on its capital the company felt it would be best to apply its funds to its own business rather than to Datamatic. □

**Because of a decline in the demand for the types of chemical cellulose produced at its Shelton Division,** Rayonier discontinued operations at Shelton for an indefinite period beginning August 9. The Shelton mill is located at Shelton, Wash., will remain shut down until pulp demand strengthens enough to warrant reactivation. □

# See what these NEW filters can do!



- **Economical recovery of valuable material.**
- **Simplified disposal of filter cake.**
- **Choice of power openings.**
- **Rapid self-cleaning devices.**
- **Complete automation or push-button control for all filtering and cleaning actions.**

If you think cleaning filters is a messy, costly job . . . take a good look at one of the new Industrial Vertical Filters.

The dirty work of cleaning has been changed to a push button routine with self-cleaning features like air wash, sluicing devices, mechanical shakers and something that has been needed for years . . . *cake discharge outlets where you need them!*

Industrial can help you organize a filtration system that fits your process like a hand in a glove. You can quickly recover or dispose of filter cake in wet, semi-solid or dry form. Filters can be made completely automatic or with any degree of manual control desired. Arranged in pairs or series, they eliminate down time or pressure drop in continuous processing. They are available with corrosion resistant linings or temperature insulation jackets.

Why not look into the advantages of modern filtration for your process? Analyses and recommendations by Industrial cost nothing...but can lead to better product quality and more economical processing. Write or call Industrial to see a qualified representative.

**For more details on Industrial Filters, ask for Bulletin 111**




Industrial

# INDUSTRIAL

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## U.S.I. TO BUILD SECOND "INTERMEDIATE DENSITY" POLYETHYLENE PLANT

**With "low pressure" polyethylene plants in the news, and "conventional" polyethylene expanding production, U.S. Industrial Chemicals (National Distillers and Chemical Corp.) is focusing attention on the third side of the polyethylene coin with its second plant to produce an "intermediate density" material.**

The second plant to produce U.S.I. (Petrothene) polyethylene will be built at an as yet undetermined location by National Petro-Chemicals Corp. (majority owned by U.S.I. and minority owned by Panhandle Eastern Pipeline Co.). While the location is not firm yet, several Gulf Coast sites are under consideration, land has already been optioned at more than one location.

Scheduled for operation by late 1958, the new plant will produce 75 million pounds a year of polyethylene in the density range of .930 (as compared to "conventional" polyethylene somewhere near .920, and "low-pressure" somewhere near .950 to .960). Capacity of the present Tuscola, Ill., plant is 100 million pounds a year, making the company's total capacity 175 million pounds a year when the new plant goes on-stream.

#### Process

A U.S.I. modification of the conventional high-pressure process (licensed from Imperial Chemical Industries, Ltd.) will be used in the new plant. Already proved in the Tuscola plant, the modified process is under wraps, produces a non-linear polyethylene of intermediate density, U.S.I. claims it can produce a density as high as .950 by the modified high-pressure process.

Properties of the intermediate density material lie somewhere between those of original polyethylenes and the low-pressure and Ziegler catalyst types. U.S.I.'s material will probably be similar to the intermediate type being produced by Spencer at a density of .935, according to Spencer, which will stand boiling water, do much that low-pressure linear types will do.

Engineering on the new plant is not waiting for final decision on the location, M. W. Kellogg, which will design and build the plant, is already at work.

TURN FOR MORE NEWS ON
Industry ..... page 80 et seq.
Overseas ..... page 108
Research ..... page 122
Nuclear ..... page 126
Institutional ..... page 131

## SOURCE OF NEW INDUSTRIAL CHEMICALS—COAL TAR

**Koppers Co. plant in Arroyo, W. Va., will pioneer in an investigation of hitherto unexploited coal tar compounds, will also mark Koppers' entry into niacin market.**

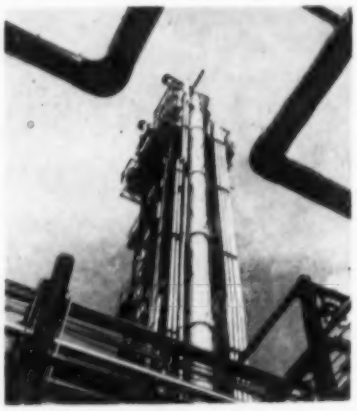
Of the more than 300 compounds definitely identified in coal tar, only a dozen or so have found commercial use. Past work has tended to be limited to chemicals which could be distilled out at temperatures up to about 500° F. Now Koppers' recently-dedicated plant will concentrate on higher-boiling compounds—those whose distillation temperatures lie between 500 and 700° F.

Koppers officials emphasize that this is "blue sky" research, that it may be years before major developments are evolved—perhaps never. Present intention is to produce new compounds in sufficient quantities to permit market exploration and development. At the same time, engineering and operating data will be stored up for possible future use in the design of commercial-scale plants.

#### Starting Material—Creosote

Initial raw material for the one-ton-per-day development plant, designed, engineered, and built by Koppers, will be creosote turned out at the nearby Follansbee, W. Va., plant of Koppers' Tar Products Division. Primary attention will be given to economic processes for the separation of phenanthrene, anthracene, and carbazole, the largest fractions contained in creosote. A major engineering problem involved is the large size of the equipment needed to recover the materials which are present in crude tar in such small amounts.

*Bonus:* Since these compounds are detrimental in certain pressure treating processes in which creosote is used, removal of the three cuts will result in upgrading the creosote.



Fractionating columns at Koppers new coal tar development plant, Arroyo, W. Va.

#### New Process for Niacin

Only present commercial product at Arroyo will be niacin (nicotinic acid), one of the B complex vitamins used as a supplement for enrichment of food and animal feed and for pharma-

(*Continued on page* 56)

## OLEFINS—FERMENTATION PRODUCTS TO COMBINE AS PFIZER ENTERS PETROCHEMICAL FIELD

**Purchase of petrochemical producer Morton-Withers Chemical Co. indicates Chas. Pfizer's growing interest in the development of products closer to the market. Pfizer is expected to react its fermentation-based materials with olefin-based materials in Morton-Withers' equipment to get high market value products.**

Entry into the tonnage production of fermentation-produced chemicals was announced by Pfizer over a year and a half ago. Now the company has purchased Morton-Withers Chemical Co. of Greensboro, N. C., with the avowed reason of getting close to olefin raw material sources.

Pfizer has in mind, according to president J. E. McKeen, "several new products which can be adapted to Morton-Withers manufacturing facilities." (At present M-W makes vinyl plasticizers, synthetic lubricant components, synthetic petroleum sulfonates, and polyester resins.)

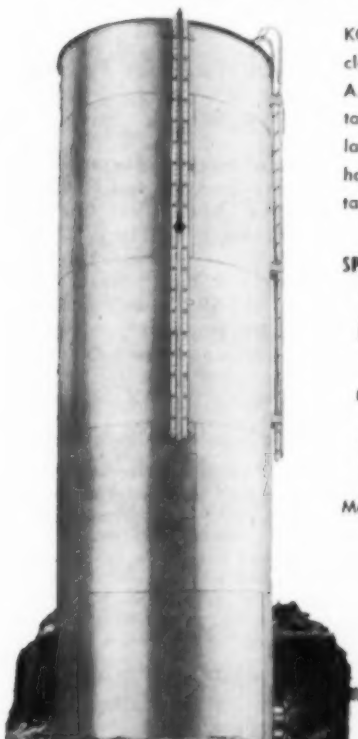
(*Continued on page* 58)

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Pictured above is what happens when a pressure vessel protected by a BS&B Safety Head develops pressures above safe limits. "Heart" of the Safety Head is the rupture disc, which bursts to relieve the overpressure instantly and completely—guarding against injuries to personnel and damage to plant equipment.

## BS&B Safety Heads

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Thousands of BS&B Safety Heads are today protecting millions of dollars worth of property and equipment and countless human lives. There's a BS&B Safety Head suitable for many types of pressure systems containing air, gas, steam or liquid.

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## COAL TAR CHEMICALS

(*Continued from page 54*)

ceuticals. A separate installation at the Arroyo plant will produce niacin from quinoline, another coal tar presently furnished by Koppers' Follansbee plant. While exact process details are being withheld, the process will probably involve a sulfuric acid treatment followed by a nitric acid oxidation step and purification by repeated recrystallization. Niacin capacity will be 500,000 lb./yr.

#### Room for Expansion

Cost of the present Arroyo installation was only about $2,000,000. However, Koppers' future hopes are clear—only about four acres of the 285-acre Arroyo site have thus far been used.

---

**A new plant specially designed and equipped for the commercial-scale production of catalysts** for its processes has been built by Scientific Design Co. in northern New Jersey. Initially, the plant will make silver catalyst for SD's ethylene oxide process. (The company will furnish the catalyst for General Aniline's new 60 million pounds a year ethylene oxide plant at Linden, N. J., now being built by SD.) Eventually catalysts for other SD processes will be made, as well as custom catalysts. □

**Production of special high grade zinc at American Smelting and Refining Co.'s Corpus Christi, Tex., smelter, will be reduced 30%.** The 2,700 ton monthly reduction amounts to some 8% of the U. S. total. Reason: according to ASARCO, reduced production in the automotive and appliance industries, coupled with decreased sales to the Government, has resulted in an oversupply and the subsequent production cut. □

**A remodeled railroad roundhouse has gained a new lease on life. Taken over by the Lithcote Corp., the roundhouse in Melrose Park, Ill., is now being used for the lining of railroad cars for the bulk shipment of chemicals and refined products. Fed by seventeen sets of tracks, it can house thirty tank cars at a time, monthly capacity is said to be 90 treated cars per month.**



**when you count the cost of corrosion**



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If corrosion is costing you money, it will pay you to check the savings that are certain with Crucible stainless steel. For all practical purposes, reactor vessels made of Crucible stainless are impervious to attack by oxidizing agents like nitric acid, and resistant to strong alkaline solutions. Mild reducing acids don't pose any special problems either, and in some cases even highly reducing acids and halogens can be handled satisfactorily by Crucible stainless steel reactor vessels.

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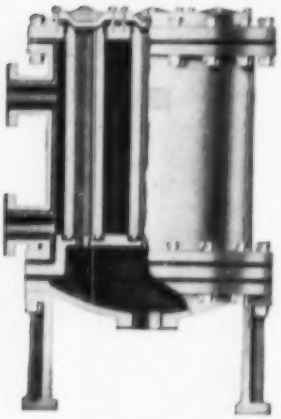
Corrosion-resistant stainless steel can be formed into almost any equipment shape or design. Write today for Crucible's free bulletin, "Making the Most of Stainless Steels in the Chemical Process Industries". Address *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

**CRUCIBLE** first name in special purpose steels

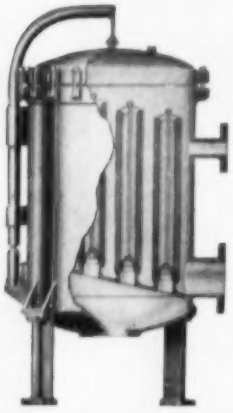
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## FOR CORROSIVE LIQUIDS



Adams CFR are rubber lined filters which meet corrosion problems that require this type construction. Where lead lining is a must, the Adams CFL filter will meet your needs. Each tubular element of either filter may be removed individually for inspection, or replacement.



Adams CVF Filters are available in Carbon Steel, Stainless Steel, Monel and Nickel construction. Also constructed with submerged head for personnel safety and with outer jacket for use with steam or refrigerated coolant to maintain desired temperature.

**All Adams Filters provide safe cleaning without disassembly by a sudden, high velocity reverse flow of backwash liquid.**

Do you have a filtration problem where corrosive liquids must be given a high polish? Where there is danger to personnel? Where there is a problem of temperature control?

The R. P. Adams Company has a line of filters which will solve any one of these problems . . . or a combination of all.

We may not have the answer to *your specific* problem, but the chances are we do. For the fastest action, we suggest you use the coupon below, or write for Bulletin 431 on your company letterhead.

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We have a problem involving the filtration of corrosive liquids.
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☐ Ask your local representative to call on us.

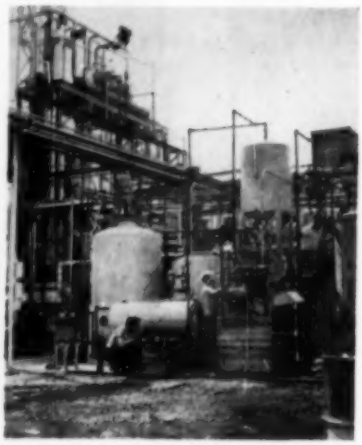
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Company _____
Street _____
City _____ State _____


## PFIZER PETROCHEMICALS

(*Continued from page* 54)

**Fermentation, Plus Olefins—New Products**

Pfizer indicates that at least some of the new products it has under study will involve olefin-based raw materials. At the time of announcing production of tonnage fermentation products, Pfizer indicated that these products would probably find use in synthetic fibers, insecticides, automotive lubricating oils, detergents, surface coatings, and plastics, among other uses.



**Acquisition of Morton-Withers Chemical Co. marks Chas. Pfizer's first entry into the petrochemical field. Need for olefin-based materials in its own work is major reason, bonus is new sulfonate process incorporated in the almost-completed pilot plant above.**

Although the company is not revealing details at present, it says it is interested in taking products derived from its fermentation processes and reacting them with olefin-based materials to produce useful intermediates which it feels will be of considerable value in the near future.

Bonus: In buying Morton-Withers, Pfizer has also acquired a new sulfonate process which will give, in the company's view, a good product at a good volume and profit.

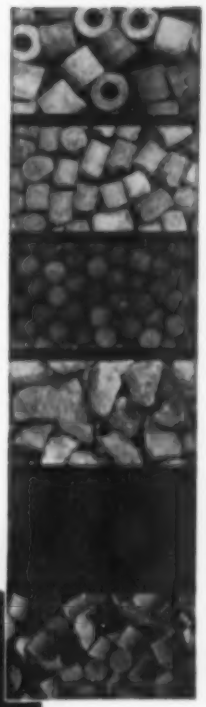
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**Raybestos-Manhattan has established a Pacific Coast Division to manufacture Teflon and Raylon products.** Means was the purchase of plant and equipment of Graef Engineering Co., located near Los Angeles. ☐

**A new engineering firm has been formed** to offer the industry combined services in all branches of engineering and chemistry. Name of the new company is Consulting Associates, location is Cleveland, Ohio. ☐

# HYDROGENATION CATALYSTS

## *How Girdler helps you solve hydrogenation problems*



• There are three important cost-cutting ingredients in Girdler catalyst service for hydrogenation applications:

**1.** Girdler's *proven hydrogenation catalysts*, such as listed, which are providing optimum operating economy in a wide variety of uses.

**2.** Girdler's accumulated *technical know-how* which is constantly finding new solutions to difficult hydrogenation problems.

**3.** Girdler's extensive catalyst *facilities* . . . manufacturing, research, development and technical service . . . which provide the ideal catalyst for *your* application.

Outline your catalyst problem and we will make specific recommendations. Bulletin GC 1256 describes the full line of Girdler catalysts . . . available on request.



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*. . . the most important*

*investment you can make is in*

*the creative ability of men.*







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# CEP Data Service

*Engineering Data*

## EQUIPMENT

**301 High Vacuum Still Data.** 16-page booklet from Arthur F. Smith Co. outlines development of the high vacuum still. Flow diagrams and calculation data for typical operations.

**302 Dynamic Precipitator Bulletin.** Details of the Type W "Roto-Clone" dust collector. 16 pages with wiring diagrams, performance tables, engineering data. American Air Filter Co.

**303 Interchangeable Rotameter Floats.** One float can be used in any application from common flow indication to remote pneumatic or electric transmission or alarm functions. Bulletin from Brooks Rotameter Co.

**304 Submersible Pumps.** A complete packeged series, available in 4 to 7 in. bowl sizes, with horsepower up to 20 and capacities to 375 gal./min. Bulletin from Johnston Pump Co.

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**307 Process Control Instruments.** Bulletin from Hagan Chemicals & Controls, Inc. describes newly-designed line of ring balance recorders, indicators, and controllers. Full-page table of applications.

**308 Metallic Dispersion Production Units.** New units, based on impeller dispersion principle, are capable of producing complete dispersions in large volumes in as little as 30 minutes, with particle sizes as small as 2 microns. Technical data, Morehouse-Cowles, Inc.

**309 Hard Rubber Equipment Catalog.** Series of bulletins from Luzerne Rubber Co. describe wide variety of hard rubber equipment for the chemical process industries.

(Continued on page 66)

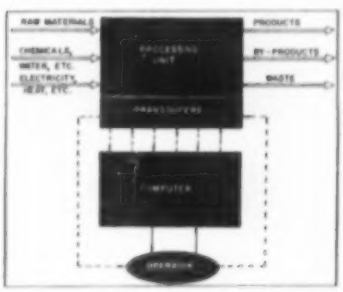
## DIGITAL COMPUTER CLAIMED READY FOR COMPLETELY AUTOMATED PLANT OPERATION

**394 Ramo-Wooldridge Corp. announces RW-300, designed to take over all control functions in industrial process plants.**

Installed as the central unit of a process control system, the RW-300 can read process instruments automatically, perform the necessary calculations to relate these readings to process objectives, determine the control actions that will result in optimum plant operation, and activate process mechanisms or adjust set points on supervised control loops.

The instrument incorporates integral input-output buffering, selection, and analog-digital conversion equipment, allowing it to be connected directly to process instruments and control devices. It can accept inputs from practically any kind of process instrument.

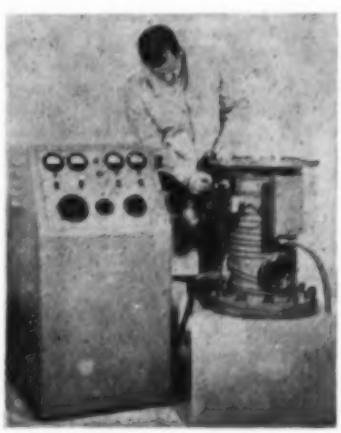
The RW-300 system can be applied to control the amounts of each of six different materials to be mixed together to form the input material to a chemical processing unit. Each of the six materials may be a mixture made up of varying proportions of six compounds. Using the equations governing the appropriate chemical reactions, it is possible to write a set of six simultaneous equations with amounts of the six materials as the unknowns. Because of the time-variant nature of the composition of these materials, it is necessary to have frequent calculation of proper flow rates to obtain product




uniformity. This can be done by solving the six simultaneous equations of the RW-300 system.

The complete program to solve the six simultaneous equations, to perform monitoring, and to determine the necessary

(Continued on page 70)



## NOVEL HIGH-VACUUM PUMP USES ELECTRONIC METHOD

**395** The "Evapor-Ion," Type EI-2000A, by Rochester Division of Consolidated Electrodynamics, is said to provide an electronic method for producing high vacuum without the use of organic pump fluids. According to the makers, it is capable of creating a "dry" vacuum in the range from $10^{-4}$ to $10^{-8}$ mm. Hg. It pumps active gases by the action of evaporated titanium wire, and inert gases by ionizing them and burying them under a layer of titanium.

Pumping speed is 1,900 liters per second for nitrogen, 1,000 for oxygen, and 3,000 for hydrogen. No refrigerated traps or baffles are required. Mechanical forepressure pumping for continuous operation is not needed.

(Continued on page 72)

# CEP Data Service

*Engineering Data*

## EQUIPMENT

**301 High Vacuum Still Data.** 16-page booklet from Arthur F. Smith Co. outlines development of the high vacuum still. Flow diagrams and calculation data for typical operations.

**302 Dynamic Precipitator Bulletin.** Details of the Type W "Roto-Clone" dust collector. 16 pages with wiring diagrams, performance tables, engineering data. American Air Filter Co.

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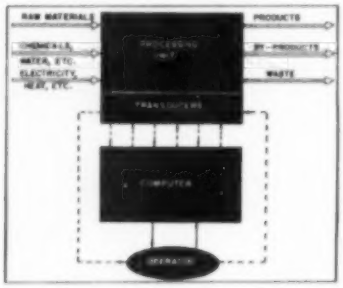
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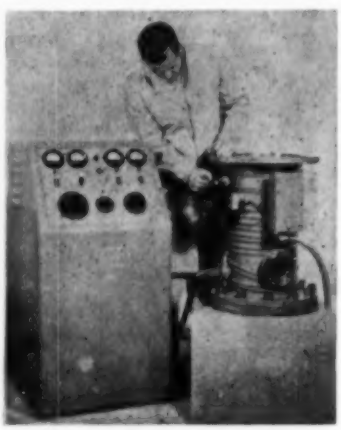
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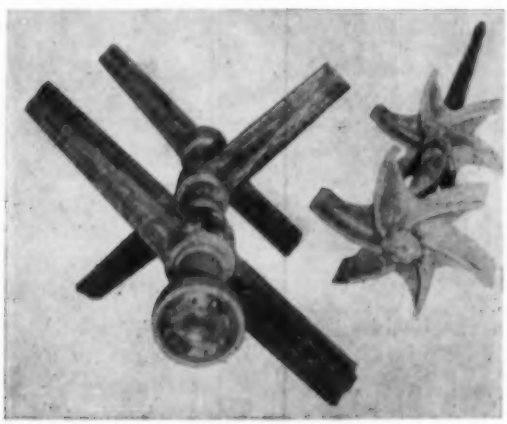
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(Continued on page 72)

## DEVELOPMENTS OF THE MONTH (Cont.)



**396 Protective Spray for Bulk Materials.** A new spray, developed by the Johnson-March Corp., blankets and effectively protects outdoor storage piles of bulk materials against all types of weather conditions for periods up to a year or more. The product, called Permaspray, is a colloidal suspension in water of a chemical which forms a tough, flexible, water-resistant film when exposed to air and hardened. It is suitable for coating stock piles of coal, ores, coke breeze, flyash, sulfur, sand, paint pigments, and all types of materials in dead storage regardless of composition or particle size. The spray is said to be non-toxic and non-corrosive. It will set in 24 hours under normal climatic conditions. The deposited film resists the action of wind, rain, frost, and heat, stops dust nuisance, and prevents windage loss. Technical details available from the manufacturer. Circle number 396 on Data Post Card.



**397 Large Diameter Plastic Impellers.** Haveg Industries offer plastic agitators with blades up to 10 inches in diameter. A completely-enclosed steel drive shaft, protected from corrosion, provides internal strength for severe operating conditions. The agitators are said to outwear stainless steels and to provide maximum corrosion resistance at less cost. They are recommended for all free-flowing liquids and thin sludges. Models for heavy slurries can be designed to meet individual conditions. Technical details and specifications available from Haveg Industries. Circle number 397 on Data Post Card.

(Continued on page 63)

**Numbers followed by letters** are for checking your interest in the products, equipment, and services advertised in this issue, the number corresponding to the page on which the ad appears. Letters indicate position on the page: L, left; R, right; T, top; B, bottom. A indicates a full page; IFC, IBC, and OBC are cover advertisements. **Numbers in the 300-series** bring you new engineering data in the chemical engineering field.

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44A 408A 45A 47A 48L 49A 50L 51A 52L 53A 55A
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147A 148L 148R 149TL 149BL 149TR 149BR 150L 151BL 151R
152TL 152BL 153TL 153BL 153TR 153BR 159TR 159BR IBC
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## DEVELOPMENTS OF THE MONTH (Cont.)




**398 Ammonia Technical Data Book.** Nitrogen Division, Allied Chemical & Dye, offers a new, 68-page technical data book on anhydrous ammonia and ammonia liquor. The book fully describes the two materials, listing their chemical and physical properties, specifications, handling and storage features, unloading methods and analytical procedures. It includes an extensive bibliography. Graphic illustrations include data pertaining to viscosities, densities, boiling and freezing points, and other important characteristics. Circle number 398 on Data Post Card.



**399 Chlorinated Hydrocarbons Booklet.** An illustrated, 20-page booklet which describes the uses and properties of five important chlorinated hydrocarbons is offered by Stauffer Chemical Co. The publication contains complete technical data including typical analyses, solubilities, flash point and density tables and graphs, other pertinent physical and chemical information on perchlorethylene, trichlorethylene, carbon tetrachloride, methylene chloride, and chloroform. One full section of the book describes opimum handling procedures and recommended methods of minimizing wastes. Circle number 399 on Data Post Card.




**400 High Pressure Liquid Level Electrode.** An extremely high pressure, high temperature liquid level control electrode is offered by the Auburn Spark Plug Co. Model HP 10 is rated for pressures up to 10,000 lb./sq. in. and temperatures to 700° F. Construction features include a new type glass center electrode seal, a captive copper compression gasket, a stainless steel shell, and 95% aluminum oxide insulator. Other materials may be substituted to meet special requirements, but it is believed that the materials presently used for the insulator and central electrode will be satisfactory for most chemicals other than hydrofluoric acid. Further details from the manufacturer. Circle number 400 on Data Post Card.




**401 Manual on Chemicals for Adhesives.** A 24-page booklet offered by Neville Chemical Co. contains sixty-six formulas for the bonding of such materials as wood, paper, aluminum foil, glass, rubber, and plastics. Each formula is accompanied by detailed instructions on preparation and a list of the applications for which it is suitable. Circle number 401 on Data Post Card.

(Continued on page 66)

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**7A Corrosion-Resistant Equipment.** Electro Chemical Engineering and Manufacturing Co. offers 12-page bulletin and corrosion guide on equipment in wide variety of plastic materials.

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**18A Plant Design, Engineering, Construction.** Girdler is engineer-constructor for Goodrich-Gulf's new synthetic rubber plant expansion at Institute, W. Va.

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**48L Valve Bulletin and Price List.** Full information on all types of replaceable-seat valves made by Keystone Valve Corp.

**49A Contract Maintenance Service.** Catalytic Construction Co. offers a flexible force on the job only as required, with qualified mechanics available for turn-around periods.

**50L Scrubbing and Cooling Towers.** Peabody towers for cleaning, cooling, absorption of gases are compact, efficient, economical, flexible, adaptable. Peabody Engineering Corp.

**51A Special Analysis Memo on Zirconium.** Latest data on properties, fabrication. Superior Tube also makes tubing in uranium, vanadium, niobium, tantalum, and thorium.

(Continued on page 68)

NEW!

# BOWEN CONICAL LABORATORY SPRAY DRYER



**Interchangeable Nozzle or Wheel Atomization provides extreme operating flexibility**

**CAPACITY**
**15 to 80 lbs/hr water evaporation depending on inlet temperature and product drying rate**

The New Bowen Conical Laboratory Spray Dryer has been especially designed for economical product evaluation and production of limited quantities of valuable materials. Particular attention has been given to operating features and ease of cleaning. Surfaces in contact with feed material and product are stainless steel throughout. Drying temperatures are variable up to 1000°F to accomodate a wide variety of materials.

The New unit can be seen in operation, by appointment, at the Bowen Laboratory in North Branch.

## Write for Bulletin 34

*Describes the Bowen Conical Laboratory Spray Dryer in detail and gives complete technical specifications.*

**BOWEN ENGINEERING, INC.**
**NORTH BRANCH 13, NEW JERSEY**

**Recognized Leader in Spray Dryer Engineering Since 1926**

**BOWEN SPRAY DRYERS**
***Always Offer You More!***

## EQUIPMENT (*Cont.*)

**310 Proportioning Pumps and Diaphragm Valves.** Catalog "Positive Flow Control" from Hills-McCanna Co. describes in detail 4 basic models of precision proportioning pumps. Range from 0 to 730 gal./hr.

**311 High Pressure Regulators.** 8-page bulletin describes complete line of high pressure regulators made by Rockwell Manufacturing Co.

**312 Lighting System for Hazardous Locations.** Bulletin from Crouse-Hinds gives prices and ordering data on complete, explosion-proof lighting installations for acetylene and hydrogen areas. UL-approved for Class 1, Groups A & B hazardous locations.

**314 Air-Operated Valve Data.** Details and operating characteristics of Series HB Saunders valves. Sizing data and comprehensive listing of flow coefficients. Conoflow Corp.

**315 Polyvinyl Chloride Pipe.** Sizes, specific chemical applications, physical properties, temperature factors, support spacing, thermal expansion. Also flow charts and installation instructions. Bulletin from Alpha Plastics, Inc.

**316 Multi-Stage Centrifugal Pumps.** Pacific Pumps, Inc., offers bulletin covering four types of pumps for high temperature, high pressure, heavy duty service. Capacities to 2,700 gal./min., temperatures to 850° F., discharge heads to 2,000 lb./sq.in. gauge.

**317 Impervious Graphite Chemical Pumps.** "Impervite" pumps are available in 6 standard models, from 25 gal./min. at head pressure of 20 lb./sq.in. to 200 gal./min. at 100 lb./sq.in. Special designs to 1,000 gal./min. Bulletin from Falls Industries, Inc.

**318 Electronic Automatic Data Logger.** The Kybernetes Logger has no servos, mechanical operations, or stepping switches, gives accuracies of better than 0.2% for all inputs including non-linear types. Bulletin from Kybernetes Corp.

**319 Chemical Processing Equipment.** Denver Equipment Co. offers 8-page bulletin describing their latest equipment and their laboratory, engineering, and design services for the chemical industry.

**320 PVC Pipe, Fittings, and Flanges.** Booklet from Tube Turns Plastics, Inc. Complete specifications for threaded and socket types of PVC fittings and flanges of normal and high impact material. Pressure-temperature charts, chemical resistance tables.

**321 Chemical Metering Pumps.** Flow ranges to 28.2 gal./hr., discharge pressure rating to 1,500 lb./sq.in. In cast iron, carbon steel, stainless, Monel, Bronze, Carpenter 20, Hastelloy, and methyl acrylate plastic. Bulletin from Orchem Pumps, Inc.

**322 Automatic Pressure Regulator Bulletin.** For pressure control of air or steam up to 250 lb./sq.in. and 450° F. Diagrams, dimensions, and selection tables. Crane Co.

**323 Corrosion-Proof Lined Pipe.** "Fluoroflex-T-S" pipe and fittings are designed to handle any and all hot acids including hydrofluoric and aqua regia as well as caustics in high temperature and pressure applications. Technical data from Resistoflex Corp.

**324 Centrifugal Casting Catalog.** Information on custom-made centrifugal castings in more than 70 different alloy steels is contained in new catalog offered by Sandusky Foundry & Machine Co.

**325 High Speed Centrifugal Pumps.** New line of high-speed, high-head centrifugal pumps is offered by Gardner-Denver Co. Available in four sizes with capacities ranging up to 520 gal./min. Technical data.

**326 Valve Catalog.** 244-page catalog from Darling Valve and Manufacturing Co. covers gate and check valves in broad range of types, sizes, and constructions.

**327 Vacuum Equipment Bulletin.** Water jet exhausters, vacuum pumps, barometric hydro-vac exhausters. Capacity curves, capacity ratios, water consumption tables. Schutte and Koerting Co.

**328 Fabricated Flow Nozzles.** New non-corrosive nozzle, about one-fifth the weight of forged steel, is said to be less expensive, easier to handle. Technical data available from Burgess-Manning Co.

**329 Processing Equipment Fabrication.** 32-page brochure from Chicago Steel Tank Co. describes their engineering, design, and fabrication facilities.

**330 Pelleting Equipment Bulletin.** Sprout, Waldron & Co. offers booklet giving complete information on construction, operation, and installation of their new "Rotair-cool" pellet cooler and dryer with conveying system.

**331 Proportioning Control Valve.** Made for pressure range from 6,000 to 30,000 lb./sq.in. in sizes from ⅛ to ¾ in. All types of materials including stainless, Hastelloy, and Monel. Technical data available. High Pressure Equipment Co.

**332 Plastic Venturi Nozzle Bulletin.** Capacity tables, dimensional data, prices, on insert-type venturi flow nozzle fabricated of Fiberglas-reinforced polyester plastic. Builders-Providence, Inc.

**333 Liquid Handling Equipment Handbook.** 100-page brochure from Wheaton Brass Works covers loading arm assemblies, loading valves, swing joints, truck tank equipment, storage tank fittings, etc.

**334 Diaphragm Control Valve Pneumatic Actuator.** Available in three standard sizes, each size covering twelve different constructions. Three spring ranges completely interchangeable in each size and type of actuator. Details from Hammel-Dahl Co.

**335 Data Processing System.** 8-page brochure describes "a practical data system for the process industries." Beckman Instruments, Inc.

**336 Bulk Material Handling Equipment.** Brochure from Brady Conveyors Corp. describes their "Floveyor" system for the bulk handling of chemicals through a pipe line.

**337 Sealless Pump Catalog.** No stuffing boxes, glands, or shaft seals. Characteristic curves, charts with sizes, capacities, operating pressure ranges, performance data. Venton Pump & Equipment Corp.

**338 Expansion Engine for Gas Liquefication.** Designed for pressures up to 3,000 lb./sq.in. gauge, new expansion engine meets requirements for industrial refrigeration, liquefication, and separation of gases. Technical information from Cooper-Bessemer Corp.

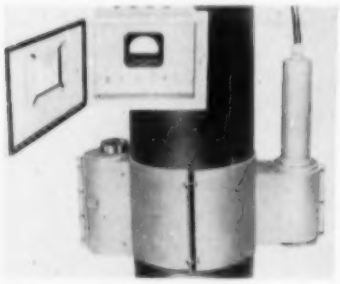
**339 Acid-Proof Sump Pump.** No seals, packing, or submerged bearings. Handles flotation products, solution transfer, frothy liquids, acid pulps, slurries. Capacities 10 to 250 gal./min. Brochure from Galigher Co.

**340 Gate Valve Catalog.** The Hamer gate valve has positive shut-off both upstream and downstream, eliminating need for double block and bleed in piping installations. Hamer Valves, Inc.

(Continued on page 68)

## DEVELOPMENTS OF THE MONTH (*Cont.*)

**402** New Type Density Gauge. Model LSG, product of the Ohmart Corp., uses gamma radiation absorption to measure or control process variables by measuring the density, specific gravity, or percent solids of the process material. Since all measuring components of the instrument are located outside the vessel which carries the process material, operation is not affected adversely by high or low temperature, pressure, viscosity, corrosion, or abrasion. Safety is assured by a lead-shielded holder for the radioactive source and lead-laminated brackets.



When manually standardized on a daily basis, plus or minus 2% of scale precision can be realized. Typical ranges are 0.2 S.G. full scale when installed on a 10 inch pipe, 0.4 on a 6 inch pipe, and 1.0 on a 3 inch pipe.

Additional technical information will be furnished by the maker. Circle Number 402 on Data Post Card.

(Continued on page 68)

## HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 3 OF A SERIES)

# Precipitation Equipment

Basically, precipitation equipment converts water impurities to the form of large, dense, suspended particles; then it separates these particles from the water.

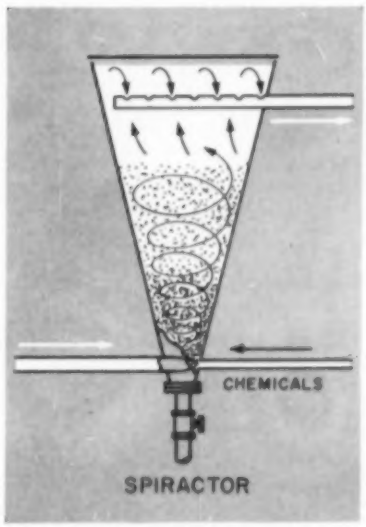
The first step is accomplished with chemicals. Hardness, for example, is precipitated by adding lime (and soda ash, if required). The precipitated hardness and other suspended impurities such as turbidity or oxidized iron and manganese are made to coalesce into larger particles by adding alum or iron salts. These salts also form their own dense, floc-like precipitate which absorbs the suspended material to form even larger particles.

The insoluble particles must then be separated from the water. Early methods used settling basins where precipitates settled slowly as the water flowed through, requiring 2 to 4 hours or longer detention time. Modern equipment keeps precipitates in suspension to serve as nuclei on which fresh precipitates form. This results in larger, denser particles that absorb more of the fine particles and are more easily separated from the water.

### PRECIPITATOR for removing hardness, turbidity, color, iron, manganese.

Chemicals are mixed with influent at A. As water flows downward through zone B, precipitates form, "seeded" by recirculated sludge. At C, floc has formed a sludge-blanket filter suspended by upward motion of the water. Excess sludge is concentrated and periodically drawn off.

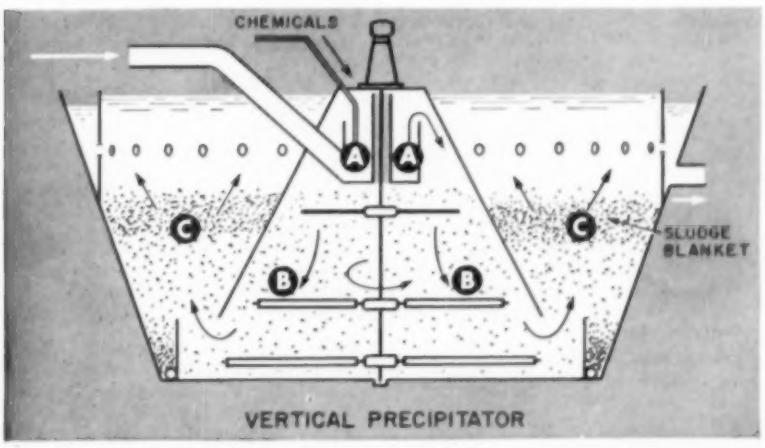
Because of short detention time, capacity is about 4 times that of conventional coagulation and settling basins of the same size. Basic designs include vertical types as illustrated, vertical types for installation in existing tanks, horizontal types built into new or existing concrete basins and smaller "package" types for bottling plants, etc.




### SPIRACTOR® for softening clear hard water.

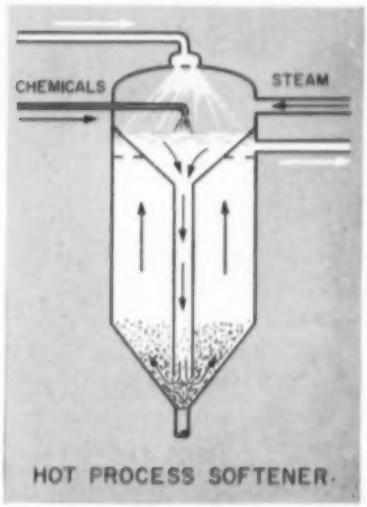
The water, lime (and soda ash if required) enter at bottom of cone. The treated water rises with a swirling motion and suspends a bed of fine granules of calcium carbonate or other catalyst which speed softening reactions. The precipitated hardness deposits on the granules which become heavy and work down to the bottom of the cone where they are drawn off then easily dried and dumped. The softened water rises above the bed of granules to the outlet.

Provides very high flow rates in relation to its small floor space. Detention period: 8 to 10 mins. Recommended for municipal or cooling water.




### HOT PROCESS SOFTENER for removing hardness and silica from boiler feedwater.

The water is first heated to within a few degrees of boiling by spraying through steam. Then it is mixed with softening chemicals which react very rapidly and efficiently at this temperature. It then flows down to the bottom and upward through a suspended sludge blanket of precipitated solids which effectively reduces silica and filters out the bulk of the turbidity. Combination softeners with built-in condensate heater and storage compartment and/or steam scrubber (deaerator) are also available.




The effluent is filtered to remove last traces of suspended matter. Where zero hardness is required, Hot Process Softeners may be followed by a zeolite softener.

• • • •

For detailed information on these or any other types of water conditioning equipment, write: The Permutit Company, Dept. CEP-9, 330 West 42nd St., New York 36, N. Y. or Permutit Company of Canada, Ltd., Toronto 1, Ont.

**PERMUTIT®**

*rhymes with "computo it"*

Water Conditioning

Ion Exchange • Industrial Waste Treatment

## *Engineering Data*

(Continued from page 66)

## MATERIALS

**367 Hydrofluoric Acid Booklet.** A comprehensive outline of physical and chemical properties and uses of hydrofluoric acid. Many charts and special handbook on methods of safe handling. Stauffer Chemical Co.

**368 Heat-Resistant Titanium Carbide Alloys.** Illustrated bulletin on "Kentanium" from Kennametal Inc., gives physical properties and corrosion resistance of 13 different compositions. These are tabulated and charted to show effects of temperature and time of exposure.

(Continued on page 74)

**59A Hydrogenation Catalysts.** Bulletin from the Girdler Co., Catalyst Dept., describes full line of Girdler catalysts including selective hydrogenation catalysts, and nickel, copper chromite, cobalt-molybdenum, and noble metal catalysts.

**60A Design and Construction Services.** Fluor Corp. offers experienced and creative engineering and construction services to the chemical process industries.

**65A Conical Laboratory Spray Dryer.** Interchangeable nozzle or wheel atomization provides extreme operating flexibility. Capacity 15 to 80 pounds per hour. Bulletin from Bowen Engineering, Inc.

**67A Precipitation Equipment for Water Conditioning.** Detailed information on precipitators and other types of water conditioning equipment available from the Permutit Co.

**79A Sealless Pumps.** Available in 7 body and 10 "flex-i-liner" materials, to handle a wide variety of corrosives and abrasives. Technical data from Vanton Pump and Equipment Corp.

**80L Heat Exchangers.** "Heliflow" exchangers assure accurately-predicted performance. Consulting services available from Graham Manufacturing Co.

**81A Process Pumps.** Complete technical information on all types of process pumps made by Aldrich Pump Co.

**82L Vacuum Mixers.** For long service at low maintenance and operating costs. Baker Perkins Inc.

**83A Carbon Monoxide Production Facilities.** High-purity carbon monoxide, maximum recoveries, automatic control, low



## DEVELOPMENTS OF THE MONTH (*Cont.*)

**403 Infrared Analyzer.** In the ammonia plant of the Mississippi Chemical Corp. at Yazoo City, Mississippi, an M-S-A Lira infrared analyzer, supplied by Mine Safety Appliances Co., checks on gas purification operations in the ammonia synthesis gas preparation step by monitoring the carbon monoxidee, carbon dioxide, and methane content of hydrogen-nitrogen make-up streams.

The M-S-A Lira is a non-dispersive type infrared absorption comparison instrument. Two similar Nichrome filaments are the separate radiation sources for the "test" and "reference" beams. A motorized reciprocating shutter, or "beam-chopper," alternately interrupts these in such a way that superimposing the two "blinking" beams would result in a steady beam.

At Mississippi Chemical, a sampling manifold arrangement allows any one of six separate gas streams to be checked for impurity content. When desired, other impurities can be determined by thee same type of instrumentation with minor internal modifications. Technical information available from manufacturer. Circle number 403 on Data Post Card.

## PRODUCTS ADVERTISED IN THIS ISSUE (*Cont.*)

**52L Oil Reclaimers.** Continuous, all-electric, automatic operation, low operating temperature, vacuum processing, low operating costs. Bulletin from the Hilliard Corp.

**53A Filter Bulletin.** Bulletin from Industrial Filter & Pump Manufacturing Co. describes advantages of their line of vertical filters.

**55A Equipment Fabrication.** In stainless, aluminum, Monel, nickel, Inconel, all clad materials, nickel-plated steel. Bulletin from Koven Fabricators, Inc.

**56L Safety Heads and Rupture Discs.** BS&B rupture discs are designed to relieve pressures at any specified pressure from 3 to 100,000 lb./sq. in. Technical data from Black, Sivalls & Bryson, Inc.

**57A Bulletin on Stainless Steels.** Booklet "Making the Most of Stainless Steels in the Chemical Process Industries" offered by Crucible Steel Co. of America.

**58L Filters for Corrosive Liquids.** Adams filters are made in rubber-lined, lead-lined, stainless, Monel, carbon steel, and nickel construction. Bulletin from R. P. Adams Co.

**69A High Temperature Engineering Service.** International Nickel Co. conducts in-plant test-rack programs to determine the most suitable alloy for a given high-temperature application.

**71A Clarifiers.** Bulletin from Centrico, Inc. describes technical features of their line of Westfalia KG clarifiers.

**73A Engineering Jobs.** Chemstrand Corp. has immediate openings for chemical, mechanical, industrial inst ument, and textile engineers.

**74L Tray Dryers.** For wet powdered sensitive or unstable materials that must be dried slowly and with utmost care. Details from C. G. Sargent's Sons Corp.

**75A New Engineering Development Center.** Lummus Co. offers 16-page brochure describing facilities of their new process development center in New Jeersey.

**76A Heat Transfer Equipment.** The Heat Transfer Division of the Lummus Co. has been acquired by Yuba Consolidated Industries. Existing commitments will be carried forward in every phase under the Yuba Heat Transfer Division.

**77R All-Teflon Mechanical Seal.** United States Gasket Co. offers bulletin describing the "Chemiseal," a chemically-impervious, pressure-balanced, Teflon bellows design mechanical seal.

power consumption, factory-assembled plants. Air Products, Inc.

**84L High-Pressure Needle Valves.** In ¼, ⅜, ½, or ¾ in. sizes. Available in 416 stainless or other alloys to special order. Bulletin from August Spindler & Sons, Inc.

**85A Data Sheets on Gas Drying.** "Molecular Sieves" give high capacity and low dewpoint at temperatures up to 200° F. Linde Co.

**87A Air Supply Bulletin.** Cooper-Bessemer offers bulletin "Air for Industry" describing their M-Line Natural Force Balance compressors, 200 to 6,000 hp.

**88L Mix-Mullers.** Three-way action assures intensive, homogeneous mix that stays mixed. Simpson Mix-Muller Division, National Engineering Co.

**89A Graphite Heat Exchanger Catalog.** Standard components in stock for immediate assembly of units having up to 3,585 sq. ft. of heat transfer surface. National Carbon Co.

**90L Vaporization Equipment.** Strong mechanical construction, tube ends all welded for maximum strength. Richard M. Armstrong Co.

(Continued on page 70)




# Here's a crystal ball

## that accurately predicts metal performance at high temperatures:

# Inco's in-plant test rack program



Do you know that Inco sets up a test rack containing a large selection of alloys in critical hot spots in many types of operations: — one rack or more . . . whatever it takes to find out which alloy stands up best under a host of varying high temperature conditions.

What's more, Inco's High Temperature Engineering Service tabulates the data . . . analyzes it in a report like the one above: complete . . . accurate . . . unbiased.

Perhaps the answer to your high temperature problem has already been found . . . if not, we will be glad to arrange for a rack test. All you have to do to get the crystal ball rolling is to fill out the coupon below. Do it now.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

Please send me the High Temperature Work Sheet so that I may outline my problem to you.

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

INCO TRADE MARK

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

## PRODUCTS ADVERTISED IN THIS ISSUE (*Cont.*)

(Continued from page 68)

**91A High-Pressure Reactors.** Autoclave Engineers offer bulletin on high pressure reactors for laboratory and pilot plant. Pressures to 100,000 lb./sq. in.

**92L Aluminum Equipment Data Sheets and Prices.** Custom fabrication facilities are available at Washington Aluminum Co. for standard or special requirements.

**93A Chemical Process Pump Bulletin.** Type DL and DM process pumps, made by Peerless Pump Division, Food Machinery and Chemical Corp., feature interchangeability of components.

**94L Rotary Joint Catalog.** Barco Type C rotary joint for steam, water, oil, or gas is effective at temperatures to 450° F. No lubrication, low torque. Barco Manufacturing Co.

**95A Heat Transfer Equipment.** Bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers. Whitlock Manufacturing Co.

**96L Heavy-Duty Screw Pumps.** For high viscosities, volumes, pressures. Full details from Sier-Bath Gear & Pump Co.

**97A Low-Temperature Process Plants.** American Air Liquide offers consulting services on cost analyses, technical aspects in design and manufacture of complete plants or components.

**98L Spray Nozzle Catalog.** Describes all types of nozzles in brass, bronze, stainless steel, or in any machinable metal. Spray Engineering Co.

**99A Industrial Jet Equipment.** "Chill-vactors," steam-jet evactors, "Aqua-vactors," fume scrubbers, special jet apparatus. Croll-Reynolds Co.

**101A Chlorine Transportation Barges.** Ingalls Shipbuilding Corp. specializes in the construction of barges for transporting hard-to-handle chemicals.

**102L Non-Clogging Sludge Pumps.** Specifically-designed to handle volatile sludges and slurries. Available in all metals and alloys. Bulletin from Lawrence Pumps Inc.

**103A Heat Exchangers.** M. W. Kellogg Co. specializes in design, engineering, and fabrication of specially-designed or standard units.

**104L Vacuum Dryer Bulletin.** The "Rota-Cone" vacuum dryer, product of Paul O. Abbe Inc., is available in sizes ranging from 0.1 to 325 cubic feet operating capacity.

**105A Packless Diaphragm Valves.** Folder from Crane Co. describes their packless diaphragm valves in which the diaphragm isolates the working parts from the fluid.

**106L Impervious Graphite Chemical Pumps.** Single-stage centrifugals employing new self-cooling and self-lubricating seal. Bulletin from Falls Industries Inc.

**107A Stainless Steel Tanks.** Fabrication by the Graver Tank & Manufacturing Co. is backed by a century of experience.

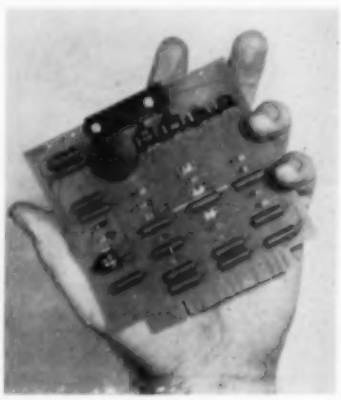
**108L Spray Drying Bulletin.** Complete facilities with laboratory, pilot plant, and commercial size spray dryers available to clients of Nichols Engineering & Research Corp.

**109A Vertical Turbine Pumps.** With impeller sizes from 4 in. diameter and up. Details from Layne & Bowler, Inc., Memphis.

## DIGITAL COMPUTER

(Continued from page 61)

valve and input settings requires about 3,000 words of storage, or less than one-half the memory space in the system. Execution of this program takes about one and a half minutes. Thus, if input data is



*Printed circuits used in the RW-300 feature an improved flush circuit technique with copper imbedded in the epoxy resin.*

available rapidly enough from the analyzing equipment, it is possible to correct flow rates of each raw material every minute and a half.

Technical data sheets and other detailed information are available from manufacturer. Circle number 394 on Data Post Card.

**110L Alloy Castings.** Furnace rollers, heat treating trays, furnace shafts, annealing belts, retorts, tubing in heat-resistant, corrosion-resistant, and abrasion-resistant materials. Bulletin from Duraloy Co.

**111A Process Equipment.** Pfaudler Co. offers bulletins on Type "W" drives, glass-lined pipe, fittings and valves, and "Buyers Guide."

**112L Heat Exchanger Bulletin.** "Paracoil" self-cleaning heat exchanger eliminates need to stop processing for cleaning purposes. Bulletin from Davis Engineering Corp.

**113A Heavy Duty Filter.** Complete facts on Model MCR heavy duty filter contained in bulletin from Sparkler Manufacturing Co.

**116L Industrial Strainers.** Elliott Co. will send complete technical data on all types of industrial strainers.

**117A Leakproof Pumps.** Available in wide choice of materials and head-capacity ranges for fluids at temperatures to 1,000° F. and pressures to 5,000 lb./sq.in. Chempump Corp.

**118TL Chlorination Equipment.** Information on slime elimination by chlorination contained in bulletin from Wallace & Tiernan Inc.

**118BL Cathodic Protection Systems.** To prevent corrosion of buried or submerged metal structures. Individually designed for each application. Bulletin from Electro Rust-Proofing Corp.

**119A Heat Transfer Medium.** Dowtherm, product of Dow Chemical Co., makes possible more compact and thinner-walled equipment.

**120L Rotameter Bulletin.** SK "Safeguard" rotameters now available with PVC end fittings. Bulletin gives detailed instructions for liquid and gas sizing. Schutte and Koerting Co.

**121A Electronic Instruments.** Complete story on "Dynalog" recorders and controllers in bulletin from the Foxboro Co.

**122TL Thermal Precipitation Equipment.** 3 different models employing continuous oscillating or gravimetric methods. Joseph B. Ficklen 3rd.

**122BL Processed Fullers Earth.** Maximum surface area and adsorption efficiency. Standard meshes from 2/4 to 200/up. Floridin Co.

**123A Continuous Dryers.** The Wyssmont "Turbo-Dryer" is designed for products which must be dried uniformly with minimum degradation of particles and without overheating. Technical data from Wyssmont Co.

**124L Swivel Joint Catalog and Price List.** Joint breaks like union for easy inspection or replacement of packing. Continental-Emsco Co.

**125A Tubing for Heat Transfer Equipment.** Electric-resistance-welded carbon steel tubing made by Babcock & Wilcox Co. assures high heat transfer efficiency by uniform wall thickness. Bulletin.

**126L Packaged Liquid Coolers.** "Flooded" packaged liquid coolers, employing the flooded refrigeration principle, are available from Doyle & Roth Manufacturing Co. in range of sizes from 5 to 100 hp.

**127A Polyethylene Tower Packing.** Increased efficiency, increased capacity, lighter weight, unbreakable units. "Tellerette" described in bulletin from Harshaw Chemical Co.

(Continued on page 72)

The Trend is to **WESTFALIA**

# WESTFALIA KG Clarifier

## Is the Choice of American Cyanamid's Lederle Laboratories



Suppose you developed an extraction process involving two difficult liquid-solid separations, where the specific gravities of the phases were very close to one another? Faced with this tough problem, engineers at famed Lederle Laboratories chose a WESTFALIA KG-10006 Clarifier. So pleased are they with its efficient performance, that Lederle engineers call the WESTFALIA KG "the best machine on the market for this type of production."

At Lederle, the WESTFALIA KG first clarifies an acid colloidal suspension. The pH of the retained liquid is adjusted for optimum precipitation conditions. A precipitating agent is added to floc out valuable solids. Clarifying the new suspension, the WESTFALIA KG runs uninterruptedly for eight hours, and recovers about 150 pounds of solids per run. By utilizing a second set of bowl inserts, downtime can be reduced to as little as 20 minutes!

The record-breaking efficiency of the WESTFALIA KG is due mainly to the unique design of its extra-large six-chamber bowl. Unlike other clarifiers which have a single tubular bowl – and which lose efficiency rapidly as soon as the solid cake begins to build up – the WESTFALIA multi-chamber bowl runs many more hours before shutdown is necessary — and its efficiency is just as high at the end as it is at the start of a run.

Won't you let us show you how a WESTFALIA KG can solve YOUR processing problem?

### *Have You Thought of a KG Clarifier in YOUR Industry?*

- **CHEMICAL** – Clarification of caustics and other textile processing solutions, acetate and latex solutions, solvents, glue, india rubber solutions, ink. Recovery of catalysts.
- **PHARMACEUTICAL** — Clarification of insulin, serum, plant and animal organ extracts and bacteriological cultures.
- **FOOD** — Clarification of sugar syrups, vegetable and fruit pulp, butter color, coffee extract, cocoa butter, vinegar, essences, meat and yeast extracts, gum arabic.
- **OIL PROCESSING** — Polishing of mineral and vegetable oils. Clarification of petroleum, cutting and grinding oils, dry fats.
- **PAINT AND VARNISH** – Clarification of resin and oil varnishes, lacquers, shellac, chlorinated rubber, enamels, and linseed oil.



The secret of the KG's constant high efficiency lies in the superior design of the WESTFALIA six-chamber bowl. Want to know why? Write for your free copy of Bulletin No. 2007.

WESTFALIA SEPARATOR | CENTRICO INCORPORATED

Centrico, Inc., Centrico Building, Englewood, N. J., LOwell 9-0755

## PRODUCTS ADVERTISED IN THIS ISSUE (Cont.)

(Continued from page 70)

**128TL Consulting Service on Sealing Problems.** Durametallic Corp. has an extensive Service Record File which may contain the answer to your specific sealing problem.

**128BL Pilot Plants and Processing Equipment.** Artisan Metal Products Inc. specializes in pilot plant and special continuous or batch complete processing units.

**129A Mixers.** For complete dispersion, consistency, uniformity, and quality. Read Standard, division of Capitol Products Corp.

**130L Water Purification Equipment.** Bulletins from Barnstead Still & Demineralizer Co. on water stills, demineralizers, and submicron filters.

**130BR Liquid Oxygen and Nitrogen Units.** Hofman Laboratories, Inc., offers new 16-page catalog of low temperature apparatus.

**131L Centrifugal Pump Bulletin.** Sizes from 1 to 4 in., capacities from 50 to 500 gal./min., heads from 30 to 220 ft. Frederick Iron and Steel, Inc.

**131R Process Equipment Fabrication.** Goslin-Birmingham Manufacturing Co. offers world-wide service to users of mechanical and heat transfer equipment, including custom design and foundry service.

**133A Plant Design and Construction.** Complete plants for the chemical, petroleum, and petrochemicals process industries. Blaw-Knox Co.

**134BL Laboratory Glassware.** Bulletin "Supplement K" from Ace Glass, Inc. lists new Kimble line of "Kimex" laboratory glassware.

**135R Industrial Wire Cloth Catalog.** Nine weaves, ranging from the finest to the coarsest, in any metal or alloy. Cambridge Wire Cloth Co.

**136TL Skin Irritant Protection.** Two types of "Kerodex" available for "wet" and "dry" work. Full information from Ayerst Laboratories.

**136BL Germanium Rectifiers.** Complete package rectification units for operation of electrolytic cells. Sel-Rex Corp.

**137R Filters.** "CloRite" filters, product of Croll-Reynolds Engineering Co., are available with from 5 to 185 sq. ft. of filtration area, in carbon steel, stainless or lined carbon steel. Technical information will be sent.

**138L Temperature Instruments.** Controllers, hand pyrometers, thermo-couple wire and insulation. Full particulars from Claud S. Gordon Co.

**138R Package De-ionizer.** Three models available, each in a wide range of standard sizes. Complete details from Illinois Water Treatment Co.

**139R Air Drying Systems.** Bulletins from Niagara Blower Co. describe their controlled-humidity method using "Hygrol" moisture-absorbent liquid.

**142L Fused Silica Laboratory Ware.** Illustrated bulletin from Thermal American Fused Quartz Co. describes their line of "Vitreosil" lab ware.

**143R Automatic Tank Gauge.** Vapor Recovery Systems Co. offers full technical information on the "Varec" Figure No. 2500 Series automatic tank gauge.

**144TL Adjustable Sprocket Rim.** New descriptive catalog sheet and price list from Babbitt Steam Specialty Co. covers details of their adjustable sprocket rim with chain guide for overhead valves.

**144BL Diaphragm Pumps.** No packings, no leakage, no contact between fluid handled and working parts. T. Shriver & Co.

**145TR Chemical Processing Equipment.** Dryers, coolers, ammoniators, granulators, elevators, conveyors. Technical information from Edw. Renneburg & Sons Co.

**145BR Fused Quartz-Fused Silica Data File.** Technical details on "Amersil" line of fused quartz and silica ware. Amersil Co.

**147A Industrial Crystallizers.** The Conkey crystallizer, product of Chicago Bridge & Iron Co., offers maximum benefits for a broad range of applications.

**148L Filter Press Catalog.** Complete information and technical data from D. R. Sperry & Co.

**148R Wood Process and Storage Equipment.** Corrosion-resistant, long life and low maintenance, custom designed and built. Bulletin from Wendnagel & Co.

**149TL Castings.** In gray iron, pressure iron, high tensile iron, Ni-resist, Lo-alloy iron, ductile iron. Literature from Kutztown Foundry & Machine Corp.

**149BL Chemical Process Pumps.** Bulletin from Ingersoll-Rand describes their line of "Chemical" pumps.

**149TR Complete Scintillation Laboratory.** Completely integrated precision counting unit—no need of additional equipment. Full information from Baird-Atomic, Inc.

**149BR Small Capacity Filters.** Recommended for small batches where sludge or filter aid is required. Ertel Engineering Corp.

**150L Corrosion-Resistant Plastic Equipment.** Technical literature from the American Agile Corp.

**151BL Laboratory Glassware.** Literature from Doerr Glass Co. on their line of Diamond D Blue laboratory glassware.

**151R Totally-Enclosed Motors.** Protected from corrosion, dusts, abrasives, impact, weather, spray, and splash. Details from U. S. Electrical Motors.

**152TL Heat Exchange and Process Equipment.** Condensers, evaporators, kettles, mixers, reactors, pressure vessels, heat exchangers, reboilers. Manning & Lewis Engineering Co.

**152BL Portable Mixers.** Available from 1/20 to 5 hp. Complete information from Eastern Industries, Inc.

**153TL Bin Level Indicator.** Bulletin from Bin-Dicator Co. describes features of the improved "Roto-Bin-Dicator."

**153BL Spray Nozzle Catalog.** 48-page catalog from Spraying Systems Co. describes thousands of standard industrial spray nozzle types and sizes in all materials.

**153TR Precision Bore Tubing.** Detailed catalog from Wilmad Glass Co. lists tubing in Pyrex, Vycor, and most of the electronic glasses.

**153BR Process Equipment Fabrication.** Tanks, pressure vessels, other processing equipment in aluminum, stainless, carbon steel, Monel, other alloys. Literature from R. D. Cole Manufacturing Co.

**159TR Thermo-Panel Coils.** Bulletins from Dean Thermo-Panel Coil Division, Dean Products, Inc. give technical data, design and price information on Thermo-Panel coils which can replace pipe coils in many applications.

**159BR Vacuum Equipment.** Steam jet ejectors, condensers, other vacuum equipment. Jet-Vac Corp.

**IBC Controlled Volume Pumps.** Simplex, duplex, and multiple liquid end types. Capacities from 3 milliliters per hour to 22.5 gal./min. Pressures to 50,000 lb./sq. in. Milton Roy Co.

**OBC Bulletin on Mixing.** Mixing Equipment Co. offers wide variety of brochures on various types of "Lightin" mixers.

## NOVEL HIGH-VACUUM PUMP USES ELECTRONIC METHOD

(Continued from page 61)

An improved feeder mechanism for continuous titanium wire evaporation is said to assure operation for periods up to six months without breaking vacuum.

A bulletin with further technical information is available from the manufacturers. Circle number 395 on Data Post Card.

**O CIRCLE** *your Data Service requests on the handy postcard on page 62 to*

**▶ GET** *up-to-the-minute catalogs, data sheets and bulletins on new chemical products, processes and equipment.*

# Ticket - to your future

Pensacola, Florida
Decatur, Alabama

1957

57

GROUND FLOOR ADVANTAGES

CHEMSTRAND

TECHNICAL PERSONNEL MANAGER,
Dept. CEP 9-57
The Chemstrand Corporation,
Decatur, Alabama

Gentlemen:

It is my understanding that you need for immediate employment graduate engineers in various fields, particularly chemical, mechanical, industrial, textile and instrument engineering.

I am a graduate _____ engineer. Please send me information concerning the ground floor opportunities at Chemstrand.

NAME _____

STREET _____

CITY _____ ZONE _____ STATE _____

**Mr. Engineer!** Looking for a free ride? Then this is not for you.

**Mr. Engineer!** Looking for a future filled with opportunity for accomplishment and recognition? Then this may well be the ticket to your future.

**Let's exchange facts.** Fill in and mail your ticket today!



★ **Chemstrand offers not just a job... but a career.**

★ **Chemstrand, already a leader in a dynamic, growing industry, is in its sixth expansion in five years.**

★ **The greatest future for the chemical-textile fiber industry still lies ahead. There is still time to get in on the ground floor... with The Chemstrand Corporation.**















CHEMSTRAND

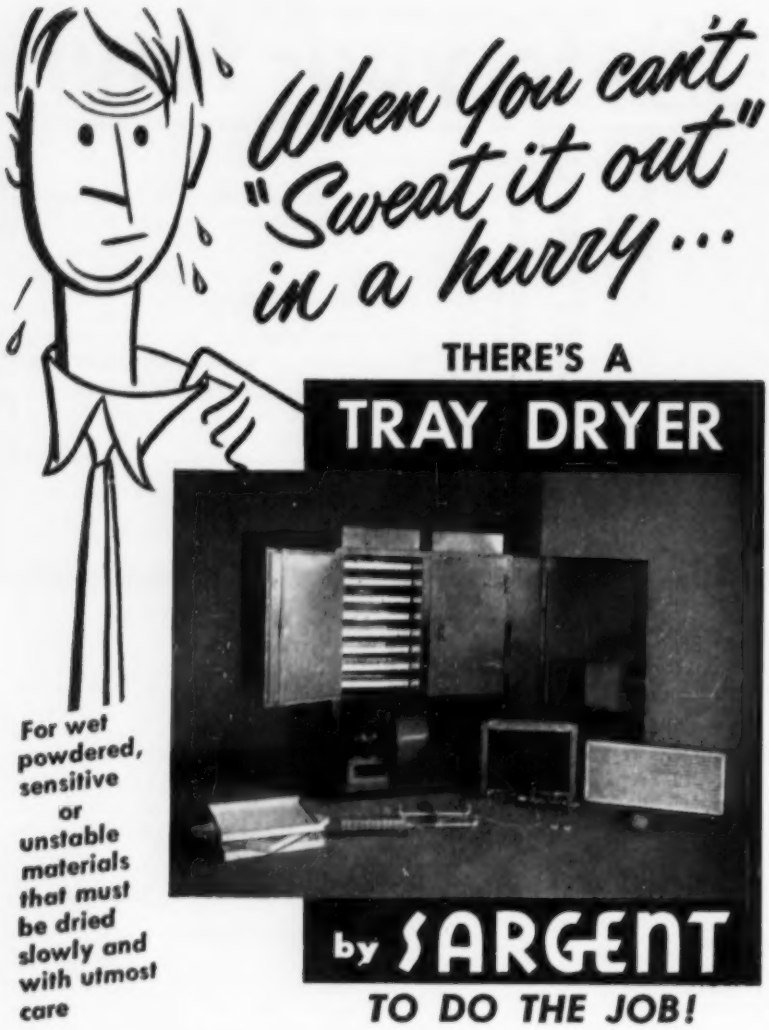
*® Acrylic Fiber by Chemstrand Corporation

## ENGINEERS

**Chemical, Mechanical, Industrial, Instrument and Textile**

Immediate openings available at Chemstrand's Nylon Plant at Pensacola, Florida, and Chemstrand's Acrilan® Plant, General Engineering Department, and Research & Development Center at Decatur, Alabama.

TOMORROW'S BIG DECISIONS WILL BE MADE **by the men who act today...**




**Sargent builds these dryers with any number of trays; single or multiple stacked; one or more deep; for highly varied drying speeds and material loads.**

The dryer above, for example, is installed in a cotton-seed oil processing plant. Another SARGENT design, for wet powdered and unstable materials, has 40 trays, 10 high, double stacked, 2 trays deep. The entire interior of this dryer-evaporator (including trays, fan, housing, inlet vanes, baffles, exhaust ports, etc.) is of a special type stainless steel. Air splitters and baffles distribute an even air flow across every tray. Guaranteed performance: a minimum of 100 lbs. water removed from a 200 lb. charge in 8 hours at 60° C.

SARGENT dryers are designed with product protection paramount. Every dryer, every new product, is "proven out" in Sargent's own expertly staffed Drying Research Laboratory, for *your* protection. Unusually rugged construction, economy and dependable guaranteed performance are Sargent standards.

***There's a SARGENT dryer to do the job for the process industries*** — **conveyor or tray; pole or tunnel; stationary or rotary. High speed or low, heavy capacity or light; continuous or batch methods. All Sargent-designed for the specific job. For more details, write**

**C. G. SARGENT'S SONS CORPORATION**

**Graniteville, SINCE 1852 Massachusetts**

PHILADELPHIA 19 — F. E. Wasson, 519 Murdock Road
CINCINNATI 15 — A. L. Merrifield, 730 Brooks Avenue
CHARLOTTE, N.C. — W. S. Anderson, Carolina Specialty Co.
ATLANTA, GA. — J. R. Angel, Mortgage Guarantee Building
TORONTO 1, CAN. — Hugh Williams & Co., 27 Wellington St. East




## MATERIALS (Cont.)

**369 1,2,6—Hexanetriol Data.** Technical bulletin from Union Carbide Chemicals Co. gives properties, shipping information, solubilities, performance data on 1,2,6-hexanetriol, a stable high-boiling liquid that offers advantages in many applications where glycerol is now used.

**370 New Type Heat Transfer Medium.** Thermon Manufacturing Co. announce "T-3," designed specially for use with coils installed on the external surfaces of process vessels, etc. The new compound fills the void spaces between the heating element and the vessel, making possible a reduction in heating surface.

**371 Corrosion Preventive for Pipelines.** 6-page brochure from Tretolite Co. discusses advantages of "Kontol," an oil-soluble, water-insoluble, semi-polar, organic corrosion preventive.

**372 New Material of Construction.** Progress report from Corning Glass Works gives properties of four types of "Pyroceram," Corning's newly-developed crystalline material.

**373 Foamed-Plastic Insulated Panels.** New process for laminating aluminum, wood, glass, porcelain, to a rigid core of foamed plastic is expected to find many industrial applications. Further information from Aluminum Co. of America.

**374 New Liquid Polymer.** 8-page booklet from Thiokol Chemical Corp. describes properties, processing, and composition of LP-31 liquid polysulfide polymer.

**375 Ceramic Fiber Material.** "Fiberfrax," an aluminum silicate material that withstands temperatures in excess of 2,000° F., is now available in many textile forms. Technical data from the Carborundum Co.

**376 Polyester Processing Guides.** Many data tables and performance graphs serve as practical working charts for users of polyester resins. Rohm & Haas Co.

**377 New Type Gasket Material.** Metex Tray Seal is designed specifically to meet installation and service conditions incident to sealing joints between tray sections in fractionating towers. Data from Metal Textile Corp.

**378 Rubber-to-Metal Adhesive.** New adhesive, Ray-Bond R-86001, developed by Raybestos-Manhattan, Inc., can be cured in 24 hours and reaches maximum strength after seven days. Detailed information available from manufacturer.

**379 Boron and its Isotopes.** Data on boron and its isotopes brought together in brochure from Hooker Electrochemical Co. Gives physical, chemical, and nuclear properties.

**380 Chemical Products Data File.** Full details on 28 of the chemical products offered by Benzol Products Co.

(Continued on page 77)



**BENCH-SCALE DISTILLATION EQUIPMENT.** The Center has various types and sizes of apparatus to distill any size sample from one cc to a tank-car load.

# Unique Lummus Engineering Development Center—30 Minutes From Manhattan—Proves Out Processes Before Construction

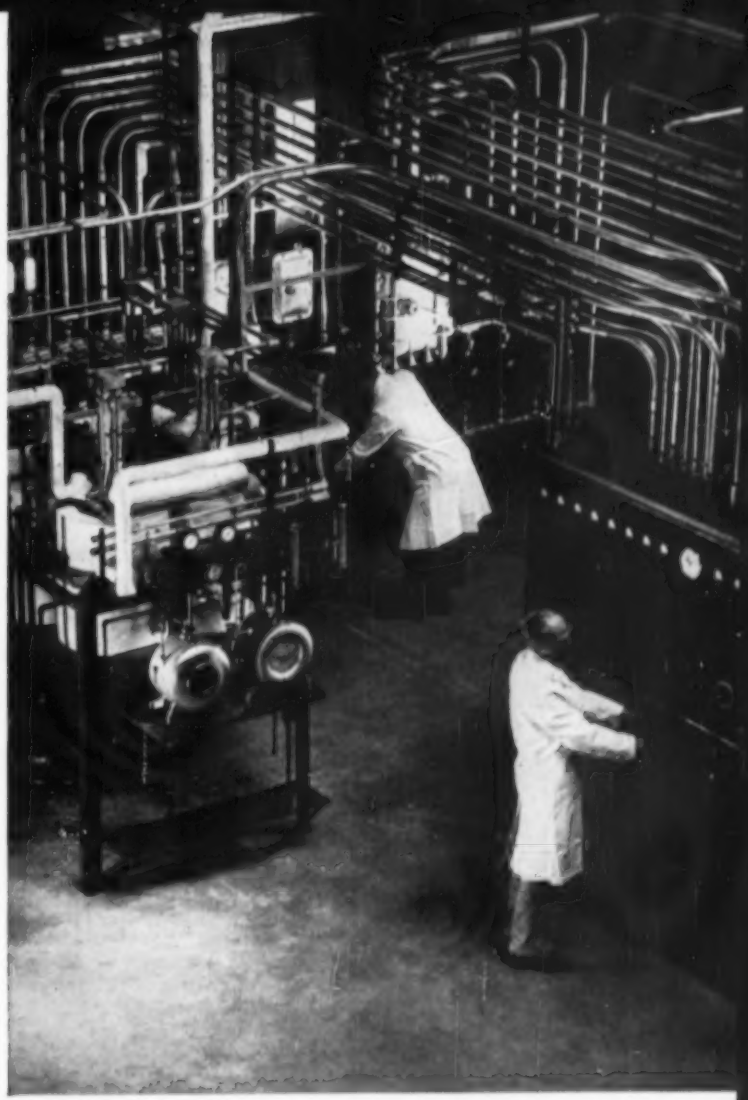
At a new 150,000 square-foot Center near the Newark Airport, the Lummus Company is expanding a long-established engineering development program into a major service to the process industries. The intensive pilot plant investigations carried out here will, in the years to come, spell the difference between rash gamble and sound plant investment for many manufacturers in the chemical, petroleum, pulp and paper and allied fields.

For a complete description of The Center and how it can help you bridge the gap between laboratory research and successful production, write for the 16-page brochure "Lummus Engineering Development Center." Address The Lummus Company, 385 Madison Avenue, New York 17, New York.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

NEW YORK • HOUSTON • BATON ROUGE • CHICAGO • MONTREAL
CARACAS • LONDON • PARIS • THE HAGUE • BOMBAY



**MOST PILOT UNITS** at The Center are put together from standard "building blocks." Skid-mounted charging units such as the one at left hold tanks, heaters and pumps for transfer and metering. Process equipment, here shown in background center, can be widely varied. At right is electrical control cabinet. All switches, relays and controls not housed in explosion-proof boxes are enclosed in cabinets like this one, pressurized with outside air to exclude process vapors.



**ANALYSIS OF MATERIALS** processed and produced in pilot operations at The Center is an important part of the work carried out by Lummus engineers. Here a laboratory technician determines the composition of a multiple-component gas, using a gas chromatography technique.

THE NAME TO WATCH IN

# HEAT TRANSFER EQUIPMENT

YUBA HEAT TRANSFER DIVISION

*formerly* HEAT EXCHANGER DIVISION OF THE LUMMUS COMPANY

Important to every user of heat transfer equipment is the acquisition of the Heat Exchanger Division of The Lummus Company by Yuba Consolidated Industries, Inc. The management, sales and engineering personnel, as well as the designs, patents, and manufacturing facilities of the former Lummus operation at Honesdale, Pennsylvania, are now part of the YUBA nation-wide organization. YUBA is proud of the opportunity to identify its name with the long established recognition enjoyed by Lummus in the power industries, as well as in the chemical and petroleum processing fields. The continuing pioneering development for which Lummus has been known, and its existing commitments and obligations, will be carried forward in every phase under the YUBA name. For your current and future requirements consult YUBA first.

## YUBA HEAT TRANSFER DIVISION

General Sales Offices and Plant—Honesdale, Pennsylvania
Eastern Division Sales Office—385 Madison Ave., New York, N.Y.
Other Yuba Consolidated Industries, Inc. Plants: Buffalo, N.Y. • Richmond, Calif. • Benicia, Calif.

YUBA
CONSOLIDATED INDUSTRIES, INC.

NATION-WIDE SALES REPRESENTATION IN PRINCIPAL CITIES

## MATERIALS (Cont.)

**381 Brochure on Adsorptive Desiccants.** Complete information on "Molecular Sieves" made by Linde Co. Tables and charts provide engineering data for preliminary design of low-dewpoint drying systems.

**382 Titanium Fact File.** 24-page booklet on physical, mechanical, and corrosion properties of titanium offered by Mallory-Sharon Titanium Corp.

**383 Silicone Lubricant Brochure.** Dow Corning offers a new 4-page bulletin on their 44 Grease, a silicone lubricant designed for effective lubrication from —40 to +400° F.

**384 Extruded Polyethylene Tubing.** Linear type, high temperature, high tensile polyethylene tubing is now available from American Agile Co. in all standard sizes in 100 foot coils. Additional information from the manufacturer.

**385 Technical Data on Pentaerythritols.** Heyden Newport Chemical Corp. offers 56-page booklet "Pentek, its Uses in Resins for the Surface Coating Industry."

**386 Acid & Alkali-Proof Cements, Linings, and Coatings.** 12-page bulletin from Electro Chemical Engineering & Manufacturing Co.

**387 Industrial Plastics Bulletin.** Complete catalog of basic forms and shapes in Nylon, Teflon, other plastics. Polymer Corp. of Pennsylvania.

**388 Polyglycol Fatty Esters.** Booklet including a tabulation of physical and chemical properties of the "Nopalcols" offered by Nopco Chemical Co.

**389 Industrial Gas Catalog.** New 1958 edition of the "Matheson Gas Catalog and Quick-Reference Manual" from the Matheson Co. gives prices and technical data on the 76 compressed gases and mixtures stocked by Matheson.

## SERVICES

**390 Engineering Services for Latin America.** Roger Williams Technical & Economic Services, S.A., is organized to provide industrial, technical, and economic studies throughout Latin America. Bulletin.

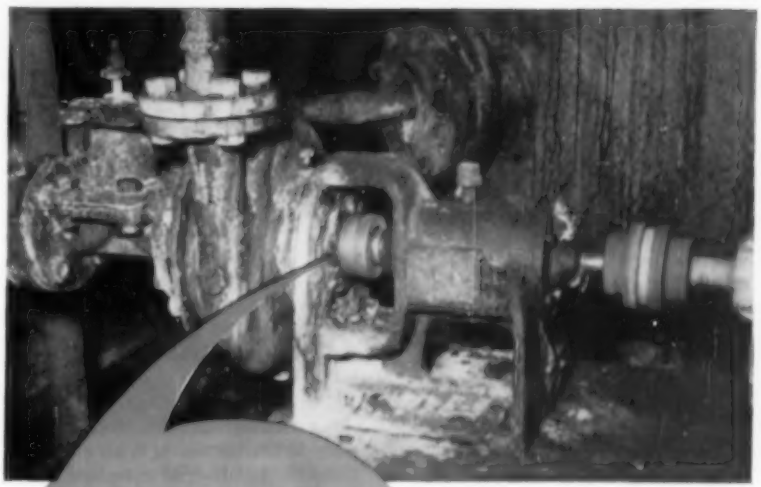
**391 Research and Development Services.** 20-page brochure from Franklin Institute Laboratories lists specific areas in which the firm is staffed and equipped to perform research and development.

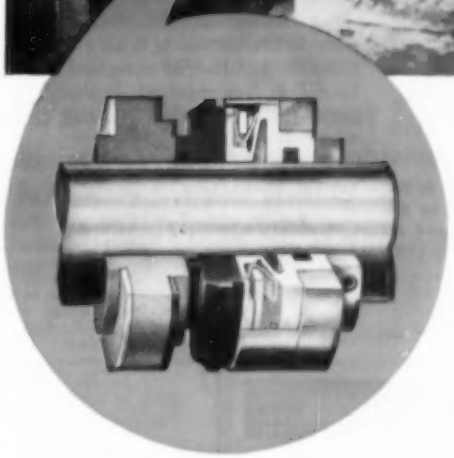
**392 Bulletin on Power Reactor Systems.** A detailed picture and word description of various systems using water, gas, sodium, and liquid fuel as coolants. General Electric, Atomic Power Equipment Department.

**393 Contract Engineering Services.** Tears Engineers offer the services of a complete engineering organization experienced in all phases of design and drafting required for the process industries. Hourly or fixed fee basis.


sealing against 95% $H_2SO_4$
at 70°C. to 90°C. for 15,000 hours
continuous service at 1750 R.P.M.

*..a Chemiseal's record at Kolker Chemical Co.*





This Chemiseal All-Teflon Mechanical Seal —first of four installed at this plant and all serving with equal satisfaction—was the third type of mechanical seal to be tried for the application, after other makes had quickly failed.

The user's comment is, "No praise is too high for this seal."

What are your shaft sealing problems? Why don't you investigate Chemiseal—the mechanical seal of Chemically Impervious, Pressure-Balanced Teflon Bellows Design. It will pay you in longer, trouble-free life.

Write for Bulletin MS-1155.

United States Gasket

**United States Gasket Company**
Camden 1, New Jersey

*Plastics Division*
OF THE GARLOCK PACKING COMPANY

# IMPINGEMENT BAFFLE-PLATE SCRUBBERS

**Impingement baffle-plate scrubbers have proved to have a wide range of applications in the chemical processing field. Such applications include purification and cooling of gases, selective absorption of valuable components, product recovery, and elimination of atmospheric pollution.**

Basic operating principles of almost any type of scrubber are:

- subdivision of the gas into many small streams;
- directed impingement of the gas streams against water droplets or against wetted targets;
- close contact between gas and liquid to insure adequate cooling of the gas and absorption of the desired gaseous components.

How these desiderata are met in the case of the impingement baffle plate scrubber is shown in Figure 1. Gas enters the lower section of the scrubber and rises through a zone of spray, usually water, created by a group of low pressure sprays. These sprays humidify the gas and strip it of coarser dust particles. The gas is now prepared for intensified cleaning action during its passage through the impingement baffle plate stage, which is flooded with water or other scrubbing liquid during the cleaning process.

The baffle plate consists of two parts: a perforated sheet having from 600 to 3,000 holes/sq.ft., and the impingement baffles above the sheet, a baffle being located directly above each perforation. The mixture of gas, liquid droplets, and dust particles attains a high velocity (about 100 ft./sec.) while passing through the plate.

Each high velocity jet is shot against a baffle directly above each perforation. Since each baffle is located at the vena contracta of the jet, the gas stream strikes the baffle at the moment of its highest velocity, giving the highest target efficiency for the pressure drop through the perforation.

The scrubbing liquid enters through the liquid inlet above the top plate, flows across the plate, down through a combination drain and liquid seal, flows across the stage below, and finally leaves through the discharge plate at the bottom. (Where virtually complete removal of entrained scrubbing liquor is required, Peabody frequently uses a positive separator of the wire mesh type.)

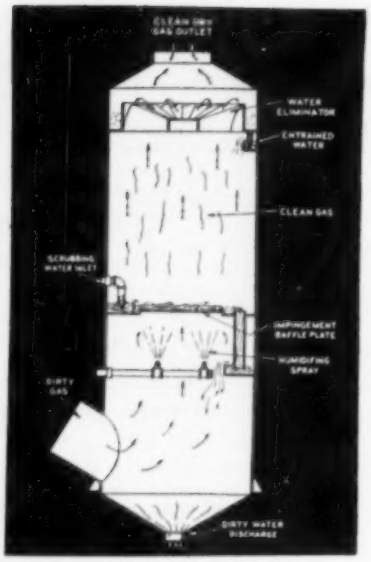



Fig. 1. Typical impingement baffle-plate scrubber (Peabody Engineering Corp.).

Applications described here, as well as the operating data given, were furnished by the Peabody Engineering Co., and are based on experience with their impingement baffle plate type scrubber.

### Typical Applications

- *Sol'As and Tar Removal from Reform Gas, with Concomitant Cooling.* This installation replaced shell and tube heat exchangers in a large ethylene plant in Texas. Much difficulty had been encountered previously with plugging of the exchangers by the tars and solid particles of carbon in the gas stream coming from the reform furnaces.

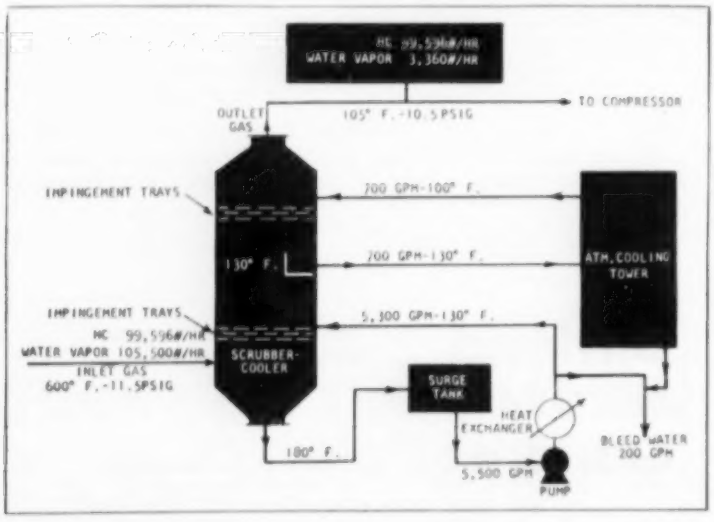
Solution of the problem resolved itself into several stages: 1) Agglomeration and removal of the heavy tar particles which might plug the impingement tray. This was accomplished by means of the spray section in the bottom of the tower. 2) removal of the fine particles which had passed through the spray by means of the impingement tray itself, and 3) cooling of the gases.

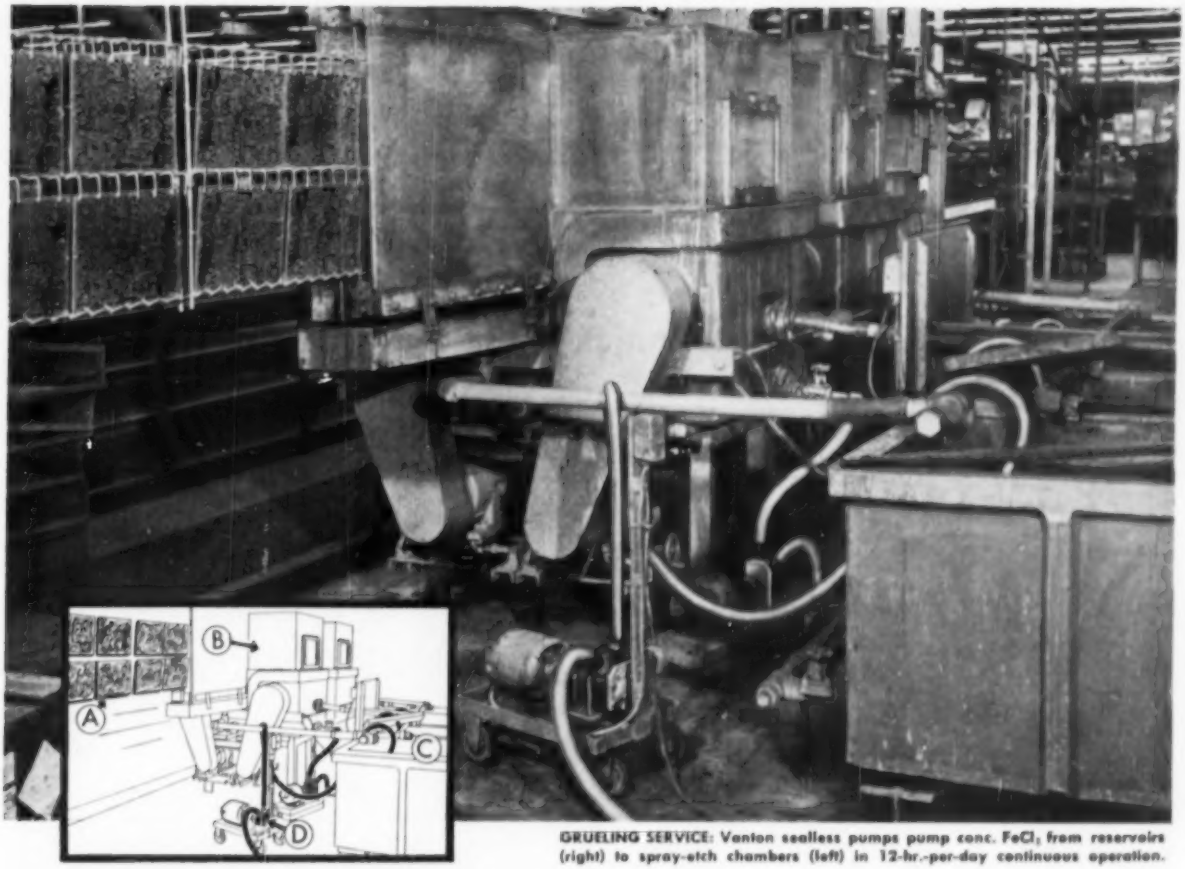
Figure 2 is a combined flow sheet and material balance of the two-fluid, closed-system cycle which was finally devised and installed. From an inlet temperature of 600° F., the gas is cooled to about 130° F. in the lower section of the tower; water leaving this section is at 180° F. and is cooled to 130° F. in a supplementary heat exchanger. The gas is further cooled to 105° F. with 100° F. water in the upper section of the tower. Water for this part of the scrubbing operation is circulated through a conventional atmospheric cooling tower.

- *Cleaning and Cooling of Gases from Fluidized-bed Sulfur Ore Roaster.* The Yerington, Nevada, plant of the Anaconda Co. manufactures about 450 tons/day of sulfuric acid starting with a native sulfur ore containing approximately 30 per cent sulfur. The raw ore is roasted in a battery of Dorrco FluoSolids reactors which produce an exit gas containing

(*Continued on page 86*)

Fig. 2. Cleaning and cooling of reform gas for ethylene manufacture.






**GRUELING SERVICE:** Vanton sealless pumps pump conc. $FeCl_3$ from reservoirs (right) to spray-etch chambers (left) in 12-hr.-per-day continuous operation.

# at WESTINGHOUSE's TV-Radio plant in Metuchen, N. J.

## *3 Vanton Sealless Pumps minimize maintenance problems in pumping ferric chloride for printed-circuit etching*

**PRINTED-CIRCUIT PROCESS** — Copper foil laminated to baseboard has circuit diagram silk-screened with acid-resistant ink (A). Conveyed into etching equipment (B), excess copper foil not covered by resist ink is etched away by warm conc. $FeCl_3$. Later, vapor degreaser removes acid-resistant ink, exposing remaining copper circuit.

**PUMPING PROBLEM** — $FeCl_3$ is pumped continuously from reservoirs (C) (overflow return), to provide fresh liquor for spray-etch chambers. Before Vanton came on job, high corrosiveness of $FeCl_3$ and abrasiveness of crystals caused much trouble with conventional pumps. Leakage at packing caused crystallization, with abrasion and scoring of pumpshafts, and expense and nuisance of increased maintenance.

**VANTON SOLUTION** — When Westinghouse changed to Vanton sealless pumps, these packing problems ceased. Each of 2 etch chambers has its own Vanton pump delivering $FeCl_3$ from its reservoir. Third Vanton pump (D, foreground) is movable auxiliary, used for cleanout of etch-spray chambers and reservoirs when $FeCl_3$ batch is exhausted. Vanton plastic materials of construction eliminated the problem of corrosion. A bakelite body block and natural rubber flex-i-liner proved completely impervious to the $FeCl_3$. Maintenance was reduced to the infrequent and simple replacement of the inexpensive flex-i-liner.

**HOW VANTON PUMP WORKS** • Liquid flows in channel between molded plastic body and synthetic flex-i-liner (*1*). No liquid touches metal. Liner flanges secured to plastic body block by bolted face plates (*2*). • Pumping mechanism is rotor mounted on eccentric shaft (*3*). At each revolution it pushes liner against body block and sweeps a "slug" of liquid around the circular track from inlet to outlet. • All bearings are outside of fluid area and located within protective stainless steel assembly in the event of flex-i-liner failure (*4*). • Liners are replaced in minutes, with pump in place, by simply removing face bolts and face plate, slipping old liner out, new one in (*3*).




**CHECK THESE VANTON SEALLESS PUMP ADVANTAGES!**

- **No stuffing box or mechanical seal to leak, contaminate, or require maintenance.**
- **Self priming; high vacuum.**
- **A full-time production tool.**
- **Broad capacity range, ⅓-20 GPM.**
- **Available in 7 body and 10 flex-i-liner materials, to handle a wide variety of corrosives and abrasives.**

**SEND COUPON FOR FACTS!**

**Vanton Pump & Eqpt. Corp., Hillside, N. J. Dept. CEP9**

My pumping problem is.....

**NAME**.....

**TITLE**.....

**COMPANY**.....

**ADDRESS**.....

**CITY**.....**STATE**.....

**VANTON PUMP**
and Equipment Corp. • Hillside, N. J.
*DIVISION OF COOPER ALLOY CORP.*




"Where she stops —" only we know — and we do know. For over fourteen years we've been rating, testing and building Heliflow® Heat Exchangers for the *sterling* of American industry.

We offer you an accurately predicted performance with no guess work — and with Heliflow its performance is for certain.

Call on our local representative for your next heat exchanger problem and you too will be impressed by the advantages offered by Graham Heliflow Heat Exchangers.

Graham

**GRAHAM MANUFACTURING CO., INC.**
415 LEXINGTON AVENUE, NEW YORK 17, N. Y.
*Offices in principal cities and Canada*

## INDUSTRIAL NEWS

**Instrument failure is blamed for the April 16 explosion at Monsanto's Nitro, W. Va., methyl parathion production unit.** An investigating committee reported that the explosion did occur in a reactor vessel during a chlorination step. Chlorination builds up heat which requires cooling of the chlorinator. A falsely low temperature reading on the vessel from the faulty instrument apparently led operators to shut off the coolant supply (a brine line cooled by ammonia). Detailed technical information on the explosion's cause has been supplied to other producers of methyl parathion, along with the steps Monsanto has taken to prevent a recurrence.

Additional process research has been carried out on methyl parathion since the explosion and has reconfirmed that there is a substantial safety factor in the company's process. Accordingly, Catalytic Construction Co. is engineering and constructing a new plant under an accelerated schedule at Anniston, Ala. Contract was finalized in mid-June, plant will be in operation by December 1. □

**Merck & Co. will produce electronic grade silicon** under the terms of a license agreement with the West German firms Siemens & Halske and Siemens-Schuckerwerke. Working through its newly-formed Electronic Chemicals Division, Merck expects to have samples available in the near future. First production is planned for early 1958. □

**Ethylene oxide, ethanol and isopropanol are three of the major products to be produced at a new plant of Union Carbide** to be built in Putnam County, W. Va. Scheduled for completion in 1960, the new plant will add 150 million pounds a year to Carbide's capacity for ethylene oxide production. □

**"Mission accomplished," says National Carbon Co.,** announcing completion of $50 million, 7-year expansion program. Program has added nearly 100,000 tons of annual capacity for carbon and graphite products. □

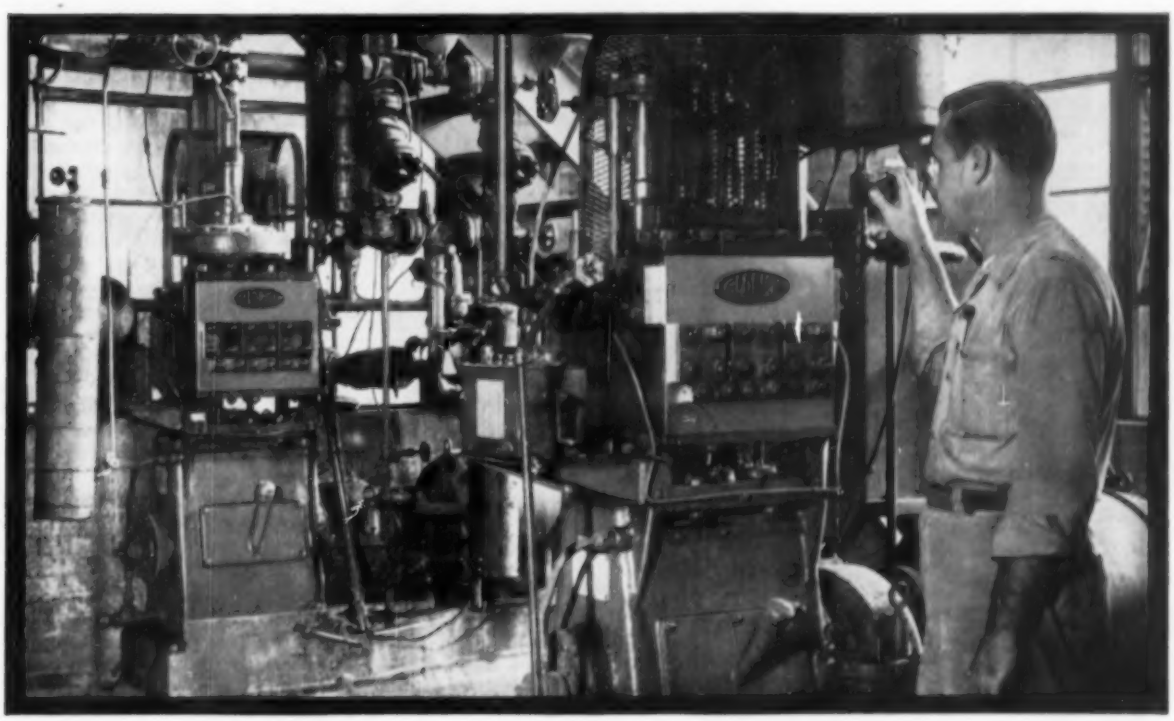
**Production of Nylon 6 is slated for November 1** at Foster Grant Company's new plant at Manchester, N. H. Grant expects to develop new end uses for Nylon 6, including blown and extended film, tubing, and pipe. □

**All properties and assets of Clorox Chemical Co.** have been acquired by the Procter & Gamble Co. □

EMERY INDUSTRIES LICKS TOUGH PROBLEM:

## How to pump fatty acids 24 hours a day, 7 days a week, and cut maintenance costs!

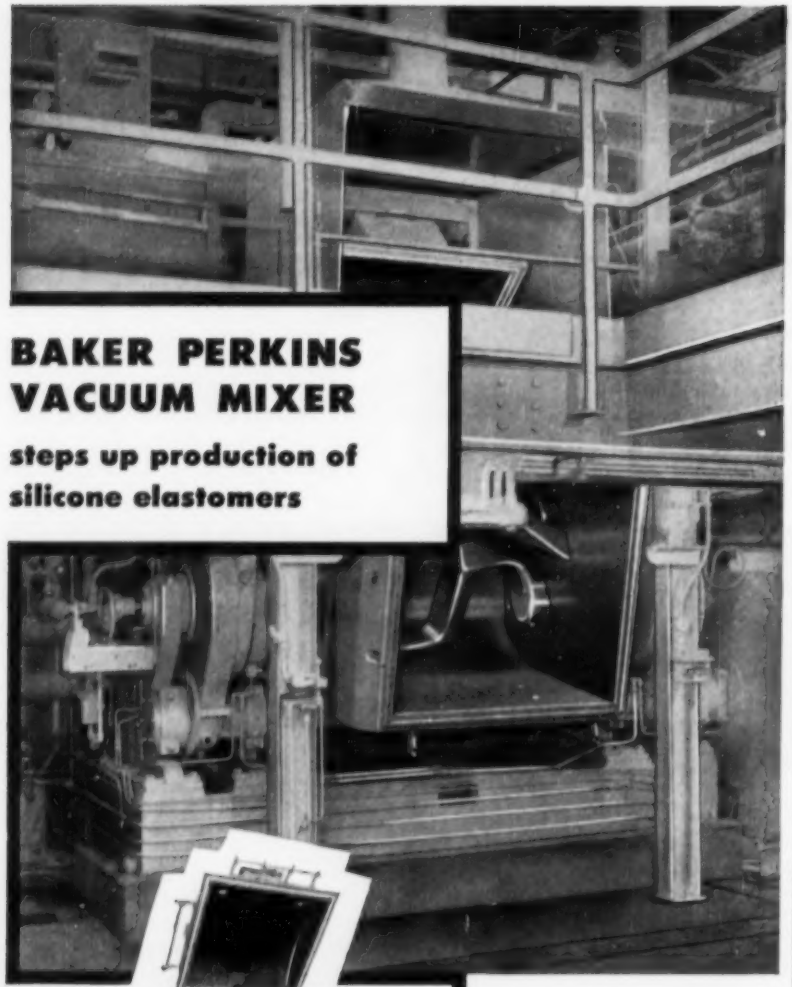
Around-the-clock hydrolysis produces fatty acids from animal fats, tallow, palm, soybean, cottonseed and corn oils at Emery Industries plant in Cincinnati, Ohio. Pumps work on hot corrosive fatty materials 24 hours a day, seven days a week, and maintenance used to be a costly problem. Packings had to be replaced far too often. Valves needed frequent refacing. Wear of plungers was excessive.



**How Emery solved the puzzle:** Looking for an answer to the problem of excessive downtime and maintenance, Emery conferred with several pump manufacturers. Aldrich was the only company to offer a pump better in both design and materials . . . the fluid end being of stainless steel. Original, ineffective pumps were immediately replaced with Aldrich Triplex Pumps.

**Result:** Two Aldrich Pumps have pumped raw materials on a continuous basis since 1948. Two more were installed for additional capacity in 1954. Maintenance costs have been reduced substantially. Downtime has decreased to a minimum. Operating efficiency is now at an all-time high and quality of processing has improved. We'll be glad to send you full information on Aldrich Pumps and their advantages to you. Simply write Aldrich Pump Company, 20 Gordon Street, Allentown, Pa.

*the toughest pumping problems go to* ALDRICH



**BAKER PERKINS VACUUM MIXER**

**steps up production of silicone elastomers**

**• General Electric Company's Silicone Products Department is using this Size 18 Baker Perkins Mixer in the production of silicone elastomers at its modern plant in Waterford, New York.**

**The size 18JWUMM2 B. P. Mixer was designed specifically to meet this customer's exact mixing requirements. It is a big, heavy duty unit, that was built to the same high standards of materials and workmanship that have made Baker Perkins the leader in the mixer field for over 64 years.**

**The same, dependable Baker Perkins vacuum mixers which have given unfailing service in such processes as compounding paints, rocket fuel and plastics, are finding immediate and enthusiastic acceptance in still other fields . . . silicones being only one of these.**

**If your production requires dependable mixing machinery which is capable of long service at lowest maintenance and operating costs, it will pay you to consult a B-P sales engineer . . . or write us today.**

351

**BAKER PERKINS INC.**

CHEMICAL MACHINERY DIVISION • SAGINAW, MICHIGAN




## DIRECT CONVERSION OF CHEMICAL ENERGY INTO ELECTRICITY IS NOW POSSIBLE

**What has long been a laboratory curiosity—the direct conversion of the chemical energy of gases into electricity—is now a reality as National Carbon Co. has developed the first fuel cell capable of economically producing thousands of watts of power.**

Using hydrogen and oxygen gases as the fuel, National Carbon Co., a division of Union Carbide, claims to have developed a source of silent power by direct conversion of chemical energy into electrical energy.

Secret of the new fuel cell is chemically treated, hollow, porous carbon electrodes through which the gases enter the cell, and which conduct the electricity produced. The cell itself is a sealed jar into which the gases are fed through the hollow electrodes. The electrochemical reaction of the gases at the electrodes produces a current with water as the only by-product. The water is disposed of by evaporation and the cell, according to the company, has a theoretically unlimited life. (In the company's labs cells are said to have been operating eight hours a day, five days a week for the past year with no signs of deterioration.)

The efficiency of the new cell varies with how it is used, but the company estimates a general efficiency range of 65 to 85 per cent as compared to 30 to 35 per cent when the same gases are burned in a conventional steam generating system. The voltage across the electrodes is about one volt, and any voltage is possible by connecting a number of cells in circuit.

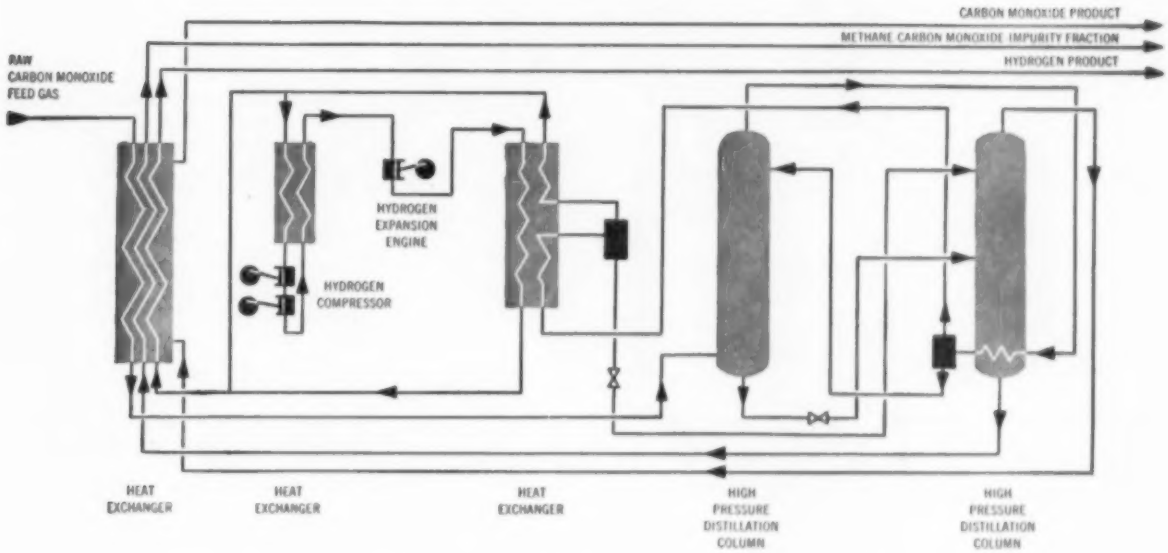
Only application so far is to provide silent electric power for the Army's lightweight, portable radar set called the "Silent Sentry." Potential, in the company's view, is any remote location where conventional fuels or water power are not available, in mobile power units, and as stand-by power plants.

### Problems Involved

The fuel cell depends, if it is to be practical, on an economical source of hydrogen. At present hydrogen gas is expensive and requires bulky pressure vessels. Coal, ammonia, catalytic cracking of petroleum, are sources

(*Continued on page* 84)

# A new approach to production and purification of carbon monoxide from crude synthesis gas




In the production and final purification of carbon monoxide from crude synthesis gas, low-temperature processing plays an important part. Synthesis gas—produced by steam reforming or various partial oxidations—contains CO, $H_2$ and some carbon dioxide. From this composition, it is possible to recover up to 95% of the CO, as a product of up to 99.5% purity, using low-temperature equipment designed and built by Air Products, Incorporated.

Air Products carbon monoxide purification plants feature:

. . . high-purity carbon monoxide and hydrogen product streams
. . . maximum recoveries—higher capital return
. . . automatic control—minimum labor requirements
. . . low power consumption
. . . factory assembled plants—with low installation expense

Low-temperature processing is not limited to just this type of gas purification. Designs are available and plants have already been built for such processes as . . . recovery of helium and nitrogen, separately, from natural gas . . . purification of methane . . . recovery of pure hydrogen from cracked petroleum off-gas streams. New processes are constantly being developed, and can be tailored to your needs.

Integrated design, manufacture, erection and operation of Air Products plants makes possible guaranteed results . . . for gas separation, liquefaction and purification systems. Plants are built to customer specifications. Ask us how low-temperature processing can be put to work for you. Your inquiry is invited. Air Products, Incorporated, P.O. Box 538, Allentown, Pa.

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CHEMICAL ENGINEERS... write today for illustrated Bulletin 101.

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## INDUSTRIAL NEWS

**Full-scale operation is under way at a new surfactant plant** of General Aniline & Film at Calvert City, Ky., site of the company's high pressure acetylene chemicals plant. Also under construction by General Aniline is a 60,000,000 pound per year ethylene oxide-ethylene glycol plant at Linden, N. J. Ethylene oxide is reacted with alkylphenols to form nonionic surfactants. □

**Three major chlorine producers contract for $4,500,000 worth of mercury arc rectifying systems**—supplier is General Electric. Twelve package units will go to Wyandotte Chemical for its new $20 million chlorine plant at Geismar, La.; four units to Jefferson Chemical's under-construction chlorine plant at Port Neches, Tex.; two to Pennsalt Chemical's Portland, Ore., installation. □

## CONVERSION OF CHEMICAL INTO ELECTRICAL ENERGY

(*Continued from page 82*)

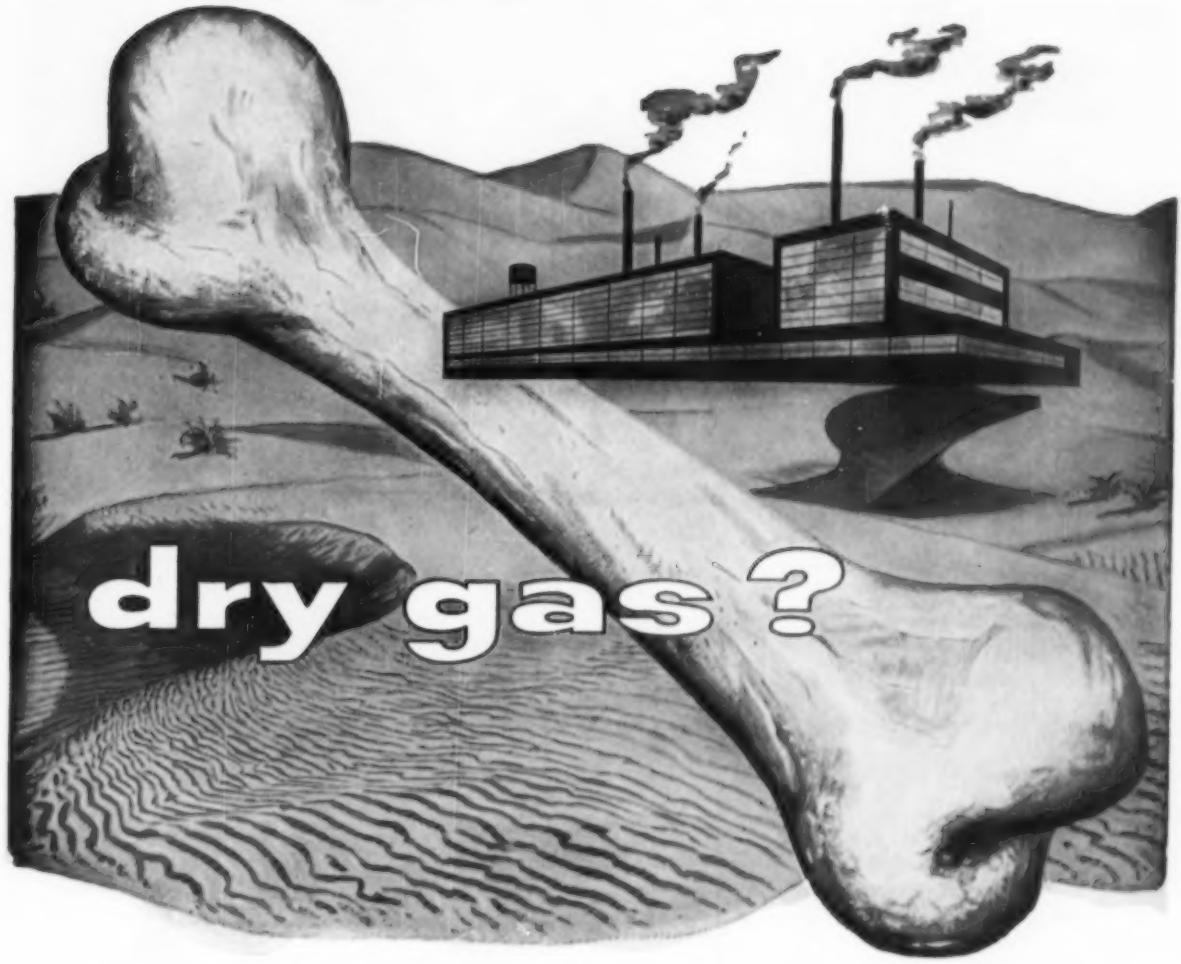
mentioned by the company. But if the cell is ever to be really competitive, a low-cost source of hydrogen is mandatory.

Another problem is that for higher current densities, pure oxygen must be used, although the fuel cell will operate on air for producing smaller amounts of power.

### Cell Construction and Operation

A number of the specially catalyzed hollow, porous carbon electrodes are grouped in a sealed cell containing a solution of potassium hydroxide. Hydrogen and oxygen enter the cell through the electrodes and diffuse through the porous carbon to its surface where they come in contact with the electrolyte. At the hydrogen electrode, the reaction with potassium hydroxide produces water and releases an electron which enters the circuit. This electron flows through the circuit and returns to the cell at the oxygen electrode where it is accepted in the reaction between the oxygen and the electrolyte. Ionic conductivity through the electrolyte completes the electrical circuit.

At present National Carbon's cell is small, still relatively experimental as far as large scale application in the process industries is concerned, but it has great potential. It is, by its nature, more efficient and logical than present sources of electrical power. □

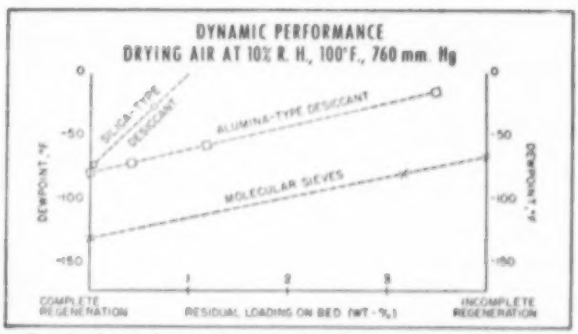



## Now you can dry gases drier than dry!

LINDE Molecular Sieves can dry your gases—air, hydrogen, chemical streams—more thoroughly than any other commercial adsorbent. They will duplicate laboratory performances—*in your plant*—under normal *production* conditions.

Even though your gas stream may already be partly dried, Molecular Sieves will remove the last traces of moisture. Only a small volume of adsorbent is required. The same combination of high capacity and low dew-point is also obtained at high temperatures, up to 200°F.

This is SUPER-drying! Dynamic performance is shown in the accompanying graph. This superior performance also can be expected at higher relative humidities and at other temperatures and pressures. Of particular significance in production is the relative insensitivity of Molecular Sieves to incomplete regeneration.




For further information, write for data sheets on "Drying of Gases." Address Dept. CP-9, Linde Company, Division of Union Carbide Corporation, 30 East 42nd St., New York 17, N. Y.

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Linde TRADE MARK MOLECULAR SIEVES

UNION CARBIDE

# IMPINGEMENT BAFFLE-PLATE SCRUBBERS

(*Continued from page 78*)

about 12 per cent $SO_2$. The exit gas, at about 1,200° F., passes first through a gas cooler where the temperature is reduced to approximately 800° F., and then through a series of cyclones in which a large percentage of the entrained dust is removed. The impingement baffle plate scrubber which follows the cyclones was designed to take gas containing dust in the amount of 5.5 grains per standard cubic foot and 100 milligrams per cubic foot of $SO_2$ (calculated as $H_2SO_4$).

Duty of the tower was as follows:

| | |
|---|---|
| Gas inlet temperature | 800° F. |
| Gas volume | 20,000 cu.ft./min., STP, dry basis. |
| Cooling water temperature | 100° F. |
| Outlet gas temperature | 105° F. |
| Water consumption | 1,250 gal./min. |

Since a definite amount of air must be added to the main gas stream to provide sufficient oxygen for conversion of $SO_2$ to $SO_3$ in the catalytic converters of the sulfuric acid plant, the major portion of this air is used to strip the $SO_2$ from the water leaving the scrubber. This stripping operation, which takes place in the bottom section of the scrubbing tower, reduces the dissolved $SO_2$ in the discarded water leaving the unit to less than 0.035 per cent by weight. Figure 3 shows a simplified flow sheet of the system.

• *$SO_2$ Absorption and Production of Sulfurous Acid.* The data which follow are taken from a typical paper mill installation for the production of sulfurous acid for bleaching purposes. Starting gas is produced in a conventional sulfur burner and enters the absorber-scrubber with an $SO_2$ content of about 14 per cent. $SO_2$ is absorbed in water in the bottom section of the tower to form $H_2SO_3$ (sulfurous acid) which is sent to the bleach plant. The exit gas from this section, containing about 2 per cent $SO_2$, is scrubbed again in the upper section of the tower with sodium carbonate to form neutral sodium sulfite which is used in the cooking liquor cycle. In the unit illustrated in Figure 4, $SO_2$ in the exit gas was reduced to 0.001 per cent.

• *Spray Drying of Kaolin.* Figure 5 shows a modern installation for the spray drying of Kaolin. About 15 per cent of the heat supplied to the spray

(*Continued on page 88*)

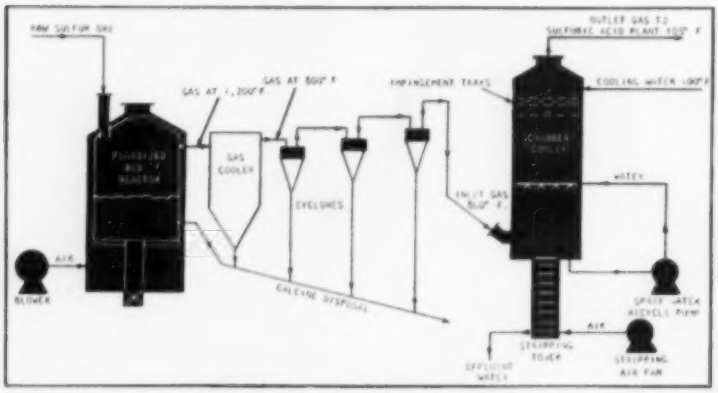



Fig. 3. Roaster gas cleaning and cooling.

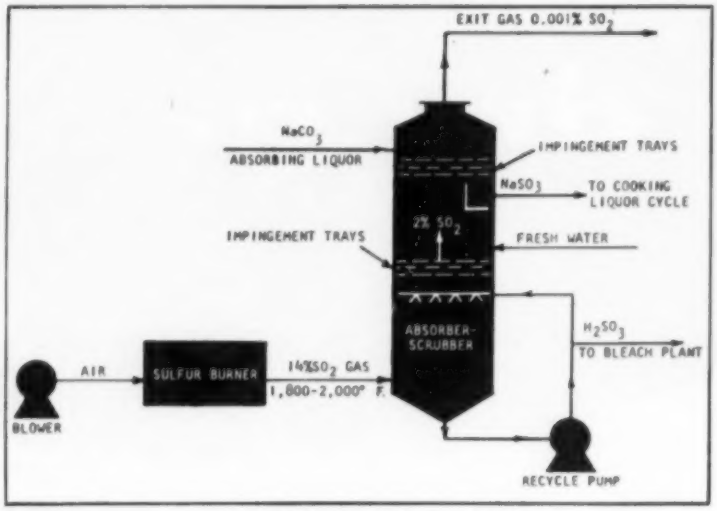



Fig. 4. Production of sulfurous acid.

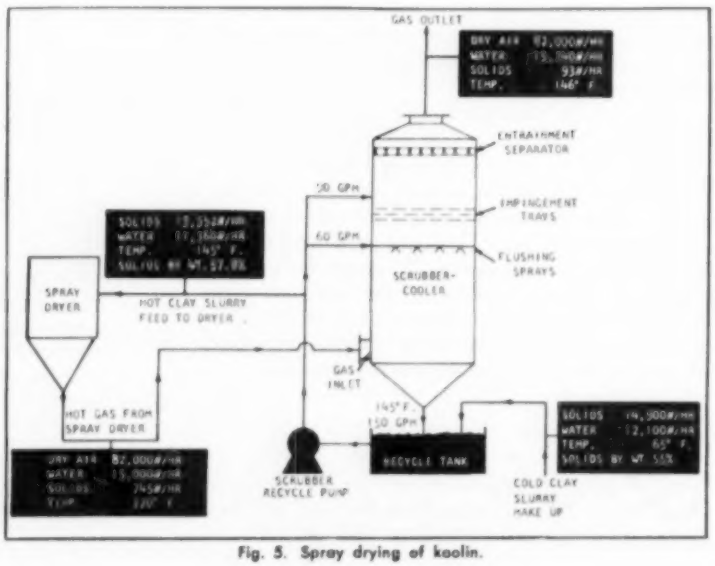
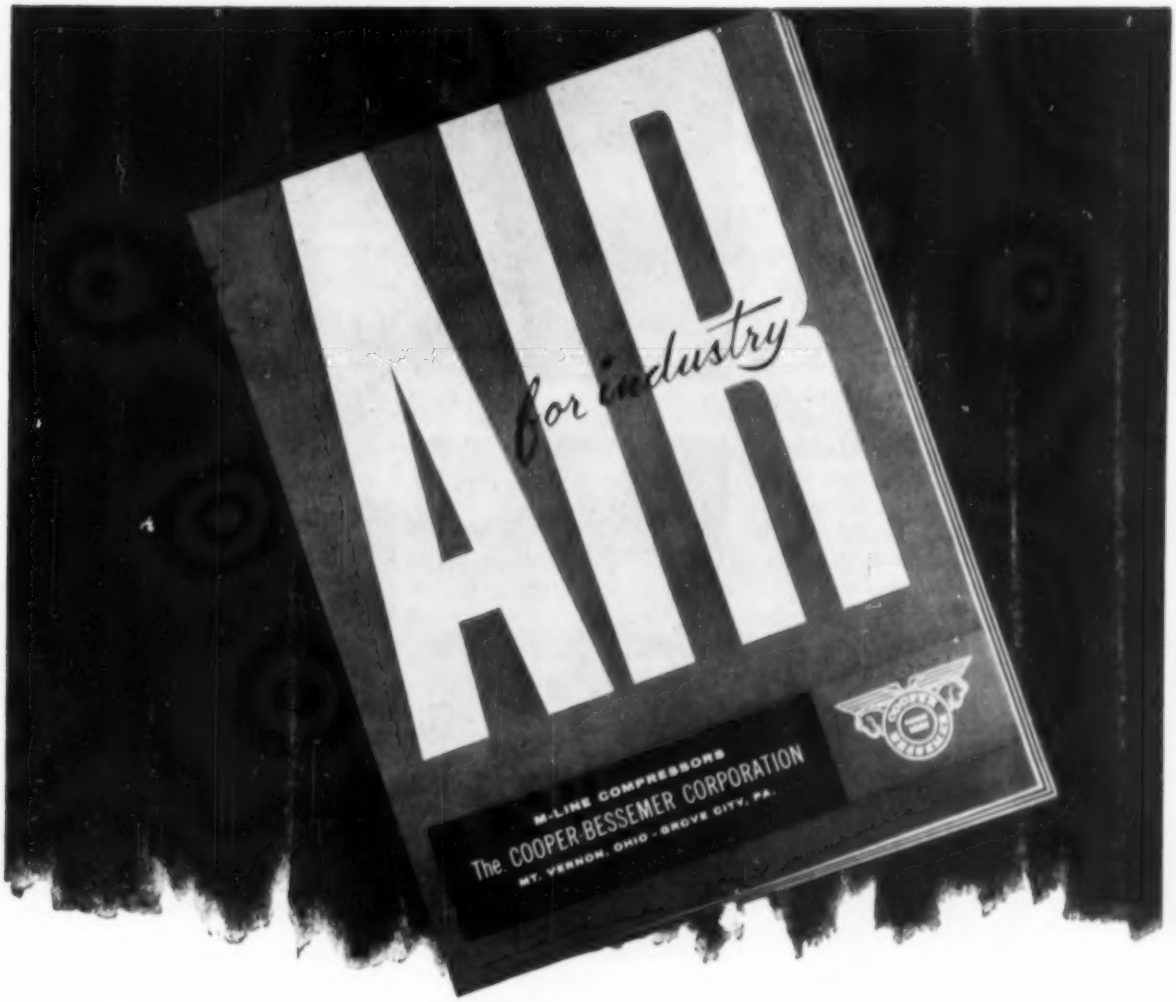



Fig. 5. Spray drying of kaolin.




# NEW BULLETIN *on meeting the need for industrial or shop air supply*

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- **Explains the advantageous new features developed by one of America's oldest engine and compressor builders.**
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*after liquid addition* mix is lumpy.



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*Gone!* Components are thoroughly blended. Mix is uniform, quickly achieved.





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## INDUSTRIAL NEWS

**About $13 million will be spent by Columbia Gas System to build an extraction plant, a fractionation plant, and a pipeline** to transport a mixed stream of liquid hydrocarbons between the two, in order to recover petrochemical raw materials from rich Appalachian natural gas streams produced and purchased in Kentucky and West Virginia.

Contracts have been executed between Columbia Gas and J. F. Pritchard & Co. of Kansas City, Mo., for the construction of the hydrocarbon extraction plant at Kenova, W. Va., and the hydrocarbon fractionation plant at Siloam, Ky. Both plants are scheduled to be on-stream about December 1, 1958.

The hydrocarbon extraction plant, which will cost about $8 million, will be owned and operated by United Fuel Gas Co., a Columbia Gas subsidiary. It is designed to recover hydrocarbons from 170 million cubic feet of natural gas a day.

The hydrocarbon fractionation plant and the pipeline will cost about $5 million.

Future plans: Columbia Gas expects that the abundant petrochemical raw materials it will produce from these plants will form the basis for a major petrochemical development, has purchased an adjoining 400 acres of land for this purpose. □

**Uranium mining, oil processing, other chemical activities in Gas Hills area of Wyoming will have new source of sulfuric acid by July, 1958,** says Davison Chemical, which plans to erect 200 ton-per-day unit at Caspar. Unique feature of the $2,000,000 plant will be use of sulfur recovered from native Wyoming low-grade surface ores as raw material. □

## BAFFLE-PLATE SCRUBBERS

*(Continued from page 86)*

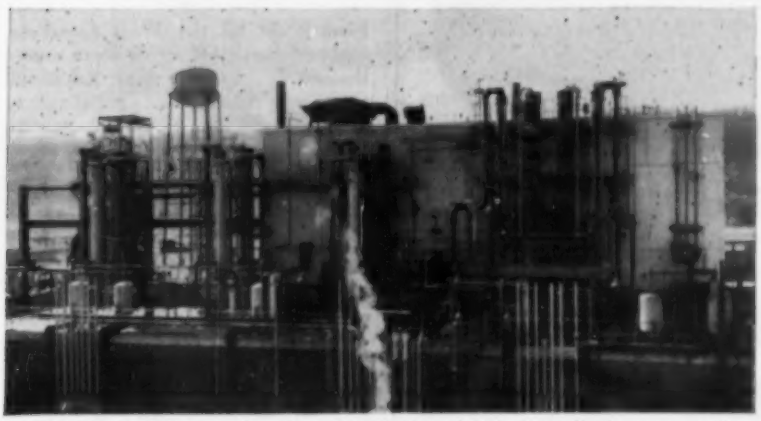
dryer leaves in the exit gas from the spray dryer as superheat. By setting up a cycle whereby the slurry normally fed to the spray dryer is first used as the scrubbing liquor in the scrubber, the heat in the gases going to the scrubber is utilized to preheat the slurry and to evaporate and concentrate the feed liquor to the spray dryer.

In the installation illustrated, recovery of clay from the spray dryer was better than 95 per cent efficient, and the thermal efficiency of the spray drying operation approached 100 per cent.

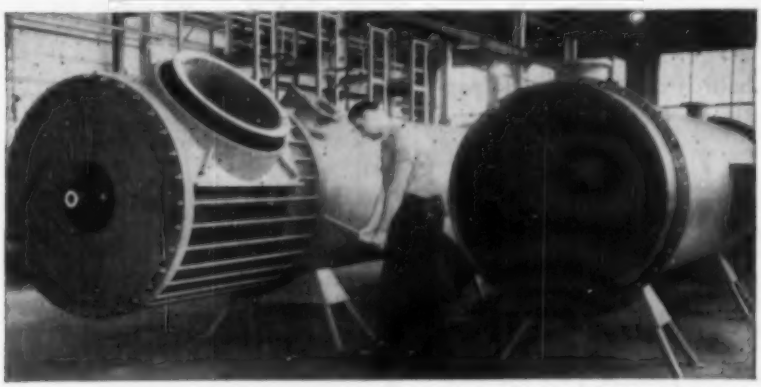
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# "KARBATE" IMPERVIOUS GRAPHITE SHELL AND TUBE HEAT EXCHANGERS PROVE THEIR ECONOMY IN COOLING CORROSIVE GASES

**Gas coolers of "Karbate" Impervious Graphite cost less and last longer than coolers made of less corrosion-resistant materials.**



Ten "Karbate" Impervious Graphite Shell And Tube Heat Exchangers cooling and condensing mixtures of organic vapors and hydrogen chloride. Units are arranged in pairs—uninsulated unit in each pair has plant cooling water on shell side; insulated unit is refrigerated.



These standard "Karbate" heat exchangers have 685-7/8" I. D. "Karbate" tubes assembled between "Karbate" tube sheets in 45" diameter steel shells. Corrosive water-saturated sulfur dioxide gas, which contains considerable entrained sulfuric acid, will enter and leave tube sides through 24" diameter connections on "Haveg" phenolic resin covers.

**National Carbon provides complete Technical Service**—An experienced technical staff designs and rates "Karbate" Shell and Tube Heat Exchangers manufactured and guaranteed by National Carbon. Dr. D. Q. Kern, well-known consultant and author of PROCESS HEAT TRANSFER, serves as an advisor to this group.

Particularly significant today is the economical cooling of corrosive gases. "Karbate" Impervious Graphite Heat Exchangers have the corrosion resistance, high thermal conductivity, immunity to thermal shock, and moderate cost vital to this service.

For cooling corrosive gases, "Karbate" Exchangers operate either horizontally or vertically, usually with the corrosive gas inside the "Karbate" tubes and with the coolant in the steel shell. These exchangers are furnished with shells of "Haveg" phenolic resin, impervious graphite, rubber or glass-lined steel for operation with corrosive gas on the outside of the "Karbate" tubes.

A complete line of "Karbate" Heat Exchangers is available in sixteen shell sizes from 6" I.D. to 45" I.D. with tube lengths of 6', 9', 12', 14', and 16'. Standard components are carried in stock for immediate assembly of units having up to 3585 sq. ft. of heat transfer surface.

For full details, request **Catalog Section S-6800NL**

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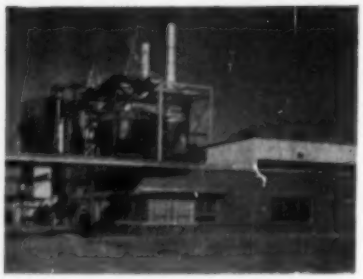
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**on how Armstrong Specialization efficiently solves your vaporization problems.**




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## INDUSTRIAL NEWS



Fluid cracking catalyst for the Canadian petroleum refining industry is now being produced domestically. Source is the new $6,000,000 plant of Davison Chemical Co. Ltd. at Valleyfield, near Montreal.

**First plant on the West Coast to make phthalic anhydride from naphthalene is on stream** at Reichhold Chemical's Azusa, Calif., installations. Capacity will be 10,000,000 pounds annually, investment cost is about $2,000,000. □

**35,000 barrels-per-day crude unit at Salt Lake City** will be designed and constructed by Fluor Corp. for Utah Oil Refining Co. Projected completion date is mid-1958. □

**Capacity will be more than doubled** at the Baytown, Texas, sulfur recovery plant of Consolidated Chemical Industries Division of Stauffer Chemical Co. Construction is scheduled to start immediately, completion date is set for early next year. Raw material for the Baytown plant consists of sulfur-containing gases from the adjacent refinery of Humble Oil & Refining Co. □

**A new division, Southeast Central Engineering, has been set up by Rayonier, Inc.,** chemical cellulose producers, to serve their plants at Fernandina Beach, Florida, and Jessup, Georgia, and their Southeast Timber Division. □

**Focusing attention again on its new "boron chemicals" plant at Lawrence, Kan.,** Callery Chemical is now offering three amine boranes in research quantities for industrial development work. The three are dimethylamine borane, trimethylamine borane, and pyridine borane. □

**Probable new merger—General Dynamics and Liquid Carbonic Corp.** The move, when completed, will mark General Dynamics' first entry into the direct chemical field. Liquid Carbonic would become a division of General Dynamics. □

# *NEW BULLETIN* on Laboratory and Pilot Plant
# HIGH PRESSURE REACTORS




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## INDUSTRIAL NEWS

**A new water-soluble, transparent packaging material is now available for industrial and consumer applications.** Developed by the Plastics Division of Reynolds Metals Co., and dubbed "Reynolon," the new material is a polyvinyl alcohol water soluble film. It can be used to package soaps, detergents, fertilizers, paints and tints, anti-rust agents, insecticides and other water dispersable products. Big advantage: when used to package agents harmful to humans, the new film will do away with any direct contact. High speed bag-forming and heat-sealing equipment for the new film is already available from one company, other companies are developing similar equipment. (See picture on page 140.) □

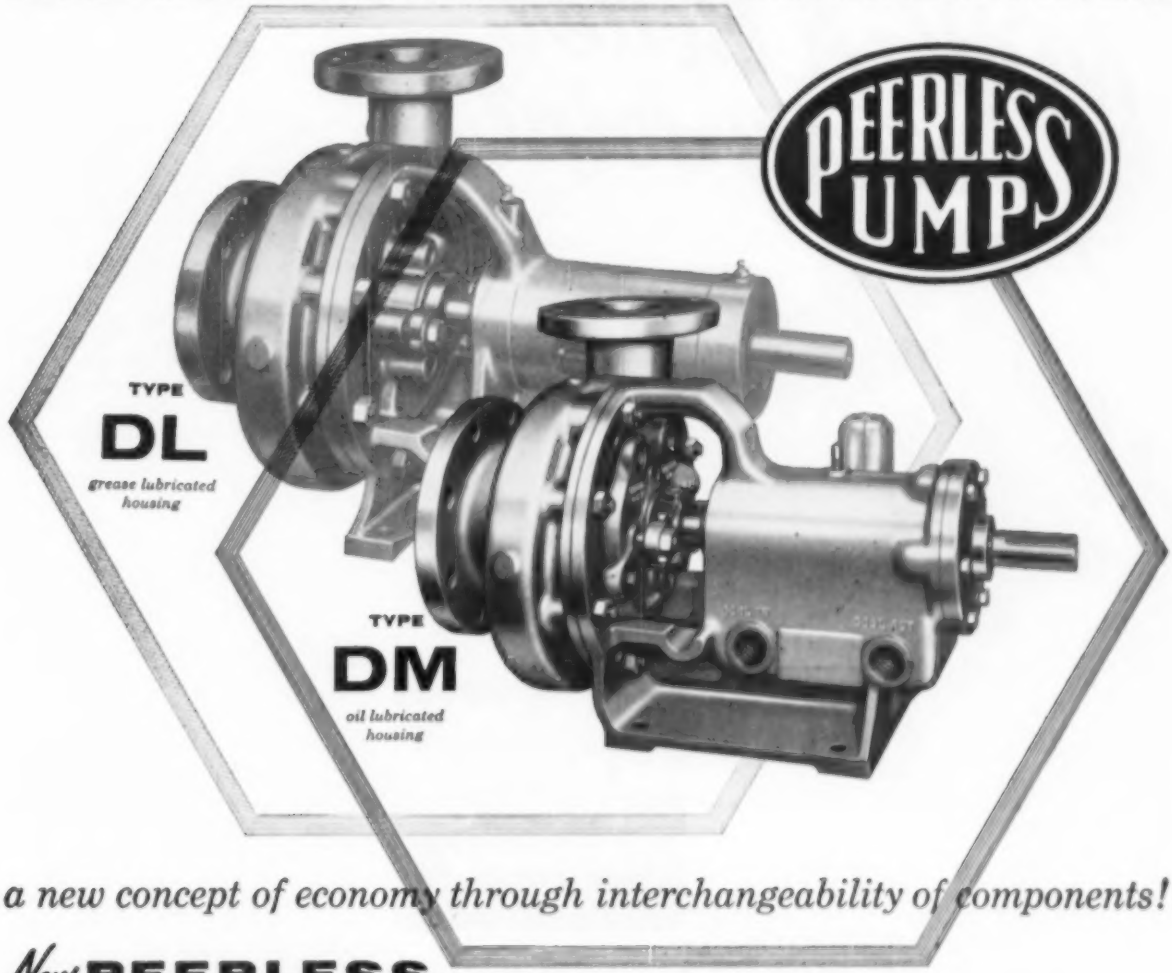
**A new 100 ton/day urea plant,** now under construction at Henderson, Ky., by Spencer Chemical, will use the Fauser-Montecatini process. This is reported to be the third U. S. plant to use the Montecatini process. The other two are Spencer's Vicksburg, Miss., installation, and Shell Chemical's plant in Ventura, Calif. □

**Capacity for the production of Darlan dinitrile fiber will be tripled** at the semi-works installation of B. F. Goodrich at their Avon Lake Development Center. Purpose of the expansion is to provide additional quantities of the new fiber for market evaluation and to obtain design data for possible production units. Completion date for the new facilities is set for early 1958. □

**"Impurities are less than one part in 6 billion,"** says Westinghouse Electric of their new ultrapurpose silicon. The company is ready to license other companies in this country for the manufacture of the new material which permits large volume production of solid state devices having two to four times the voltage and power handling capacities of those presently in use. □

**Anti-merger law violation charges have been leveled at Union Carbide** by the Federal Trade Commission in connection with the former's acquisition of Visking Corp. in December, 1956. The charges of monopolistic practices in the polyethylene resin field are being fought by Union Carbide, which states that competent prior legal advice had established the propriety of their action. □

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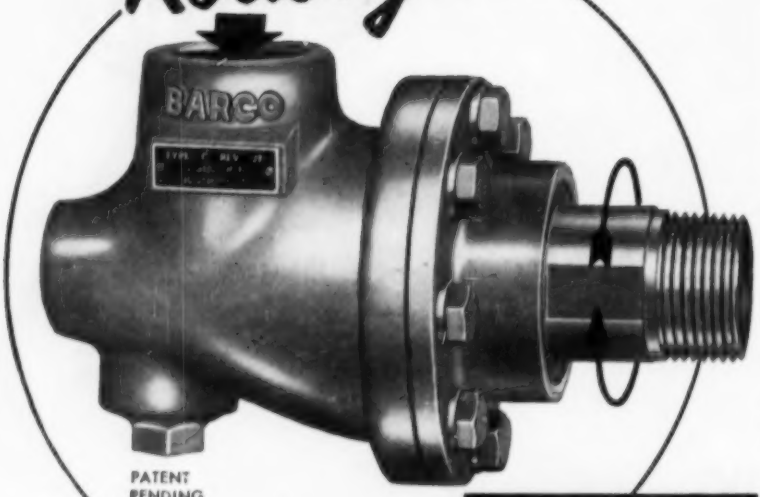
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**NEW BARCO TYPE C Rotary Joint**

## SEE IT! TRY IT!

*It's new! It's simple! It's versatile!* And for countless applications, Barco's new Type C Rotary Joint will give you the best operating records you've ever had.

**FOR ALL SERVICES**—One basic style of revolving joint for single flow or syphon flow . . . one basic seal for steam, air, water, oil, gas — *or alternating hot and cold!* For temperatures to 450°F. Special to 500°F.

**NO LUBRICATION NEEDED** — Bearings and seal self-lubricating. Seal self-adjusting for wear. Long life without repairs or maintenance.

**LOW TORQUE** — Low starting and running torque*. Saves power. Suitable for any ordinary speed. To 200 psi, steam, or 400 psi, hydraulic.

**COMPACT, SIMPLE** — Malleable iron body; heat treated steel shaft; R.H. or L.H. thread. Eight sizes, ½" to 3".

**Typical example: 12 in. lbs. starting torque for 1" Type C on 100 psi water. Rotating torque, same.*

*for*

**STEAM**
**WATER**
**OIL**
**AIR or GAS**




SEND FOR NEW CATALOG 310 TODAY.

FOUNDED 1908
BARCO
PRODUCTS BACKED BY EXPERIENCE

**BARCO MANUFACTURING CO.**
560K Hough Street • Barrington, Illinois

*The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints*
In Canada: The Holden Co., Ltd., Montreal


## INDUSTRIAL NEWS

**Floating aluminum. Anyone need it? If so, Bjorksten Research Labs have it.** They have come up with a successful continuously foamed aluminum almost as light as balsa wood. The new foamed metal has interesting properties: an apparent specific gravity less than one, i.e., it will float on water; it is fireproof and corrosion-proof; it can be sawed, nailed, cemented and bolted; and it is rigid.

The process depends on gas-forming solids such as zirconium and titanium hydrides which are suspended in a eutectic mixture of aluminum and magnesium that melts below the hydride's decomposition temperature. This suspension is injected into molten aluminum, or into a high-melting aluminum-magnesium alloy, and releases hydrogen which results in a foam. The foam is cooled before it gets a chance to subside and is thus made permanent. The process is continuous.

Only problem now is, what can foamed aluminum be used for? Bjorksten's answer: you tell them. But it seems to have a big potential as a lumber substitute in construction. □

**Alkyl amines will be produced at a new unit being installed at the Baltimore plant of American Alcolac Corp.** Said to employ a new and novel process developed by American Alcolac, the facilities are expected to be in full-scale commercial production early this fall. First product will be lauryl dimethyl amine, to be followed by higher molecular weight alkyl amines. □

**Stepan Chemical Co. of Chicago has acquired Ninol Laboratories,** also of Chicago. Sale price is reported to be about $2 million. Both firms are manufacturers of synthetic detergent raw materials. □

**A convenient new method for estimating heats of combustion of aviation gasolines** is announced by the National Bureau of Standards. The method is said not to require elaborate calculations or extensive analytical work. Basis is an empirical equation relating heat of combustion to the proportions of various hydrocarbons present. Chief use of the procedure is expected to lie in checking aviation gasolines for conformance to military specifications. □

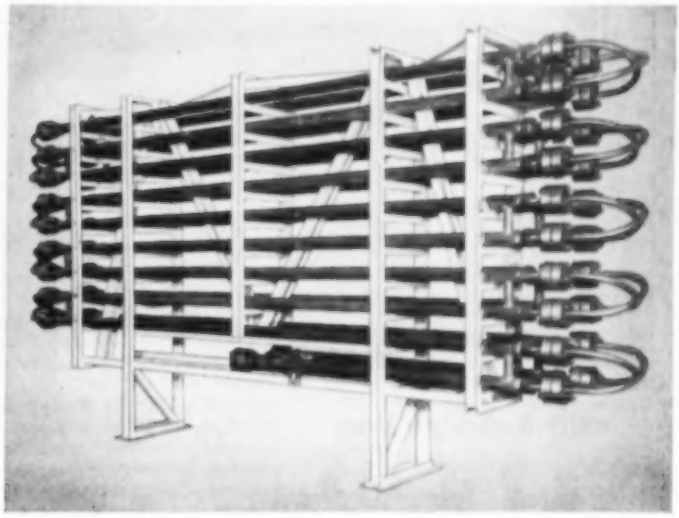
**Milton Roy Co., manufacturers of controlled volume pumps and chemical feed systems, have purchased Anders-Lykens Co.,** makers of air dryers and gas dehydrators. □

# HEAT EXCHANGERS to match your special needs



You can depend on Whitlock Heat Transfer Equipment to satisfy your most complex requirements. Whitlock designs and manufactures not only the standard sizes and types of heat exchangers, but special exchangers for high and low temperature service, for operating pressures ranging from complete vacuum to thousands of pounds per square inch, constructed of almost any workable material. These exchangers are supplied as individual units, semi-packaged systems, or packages having complete operating controls. Write for recommendations and Bulletin 250.

**THE WHITLOCK MANUFACTURING CO.**
**97 South St., West Hartford 10, Conn.**
In Canada: Darling Brothers, Ltd., Montreal



**Typical of many packaged units** regularly manufactured by Whitlock, this large convertor with auxiliary heat exchangers comprises a complete operating unit. Whitlock Engineers are thoroughly experienced in designing heat transfer equipment to meet your special operating conditions.

**A primary aftercooler** designed to remove the heat generated in compressing ethylene gas to 3700 lbs. per square inch. The inner cooler tubes containing this pressure are of heavy wall seamless steel, with their external walls protected by a cladding of admiralty metal from corrosion by the water in the outer pipes.



**Secondary gas precooler** is one of nine used with the reactor in a modern chromium ore plant. This stainless steel cooler reduces stack gas temperature from 1500° employing cooling water at about 100°F. Since it was necessary to provide means for accommodating the expansion of component parts due to the elevated temperatures, two corrugated expansion joints were included in designing the unit.

Whitlock

**Designers and builders of bends, coils, condensers, coolers, heat exchangers, heaters, piping, pressure vessels, receivers, reboilers.**

# Sier-Bath SCREW PUMPS

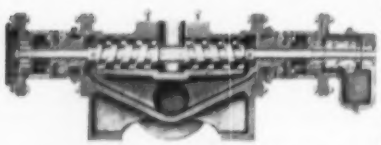


**Outstanding for heavy-duty pumping of**

**HIGH — VISCOSITIES**
**— VOLUMES**
**— PRESSURES**

● The powerful thrust and smooth, pulseless flow of Sier-Bath Screw Pumps are unexcelled for pumping asphalts, cellulosics, heavy fuel oils, greases, adhesives, molasses and other high viscosity materials. Shown below is a Sier-Bath Screw Pump at an oil refinery, handling asphalt with a viscosity of 25,000 SSU at 250° F., pumping 230 gpm. at 200 psi.

**Sier-Bath SCREW PUMPS**



External Gear and Bearing Bracket Type for non-lubricating liquids and semi-liquids



Internal Gear and Bearing Type for lubricating liquids and semi-liquids

Sier-Bath Screw Pumps maintain high volumetric efficiency because "Dual-Controlled", precision rotor design prevents rotor-to-rotor or rotor-to-casing contact—provides a continuous flow without pulsation, hammering or vibration . . . without strains, misalignment and wear on rotors, shafts, bearings and gears.

Result: Dependable, uninterrupted pumping service—less downtime—less maintenance—easier servicing—longer pump life—lower overall pumping costs.

Capacities from 1 to 1,000 gpm.; viscosities from 32 SSU to 1,000,000 SSU; discharge to 1,000 psi. for viscous liquids, 200 psi. for water and light oils. Horizontal or vertical construction. Corrosion resistant alloys, special bodies, stuffing boxes and bearings for special needs. Call your Sier-Bath representative or write Sier-Bath Gear & Pump Co., Inc., 9272 Hudson Blvd., North Bergen, N. J.

# Sier-Bath ROTARY PUMPS



Screw Pumps — Gearox® Pumps — Hydrox® Pumps

50th Anniversary — Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings — Member A.G.M.A.


## INDUSTRIAL NEWS

**Newest entrant into the dust collection and recovery field is the Fuller Co.,** whose purchase of the Dracco Corp. has just been announced. Fuller, wholly-owned subsidiary of General American Transportation, can now offer a full line of dust and fume collecting equipment as components of engineered conveying systems. □

**High-octane gasoline production will be upped** by installation of new facilities at the Perth Amboy, N. J., refinery of California Oil Co. Important new by-product will be normal hexane which will be treated to make a top-quality commercial solvent. Design capacity of the new units is 9,700 barrels per day, operation is expected by end of 1957. Design work was done by California Research Corp. (a Caloil affiliate), construction contract went to M. W. Kellogg. □

**Manufacture and sale of new alloys, pure metals, and metal chemicals** will be pushed by a new division of Electro Metallurgical Co., a division of Union Carbide. The new Fine Metals and Chemicals Division will be headquartered in Niagara Falls, N. Y., where Electromet maintains extensive research, development, and testing facilities. □

**Low bidder for the third phase of construction on the Navy-Callery Chemical $38 million HiCal plant** in Muskogee, Oklahoma, is said to be H. K. Ferguson Co. with a bid of $3,890,000. Third phase will include a portion of the chemical processing plant. HiCal, high energy fuel for jet planes and missiles, will be coming from the Muskogee plant by early 1959. □

**The only cement plant in Kentucky,** Kosmos Portland Cement Co. of Louisville, annual production 2,000,000 barrels, became a wholly-owned subsidiary of the Flintkote Co. in a recently-approved merger. Flintkote is a large user of Portland cement in the manufacture of asbestos-cement building materials, Insulrock products, and prefabricated chimneys. □

**A new synthetic rubber compound that withstands both sub-zero cold and temperatures higher than its own vulcanizing point** is announced by B. F. Goodrich Aviation Products. First use of the new material is in a lightweight membrane for the fueling system of the Bomarc area defense missile, applications in the chemical industry may follow. □

# AMERICAN AIR LIQUIDE

ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE—NEWEST IN DESIGN

529 CHRYSLER BUILDING, NEW YORK 17, N.Y.

*In Canada:* **L'Air Liquide**
**1111 Beaver Hall Hill**
**Montreal, Que.**

Our widely-experienced technical and manufacturing staff, including design, process, project and mechanical engineers, backed by half a century of "know-how," is at your service to assist you in applying low-temperature technology to your particular requirements. We shall be glad to consult with you regarding cost analyses and technical aspects in the design and manufacture of complete plants or components "tailored" to your needs.



Air Liquide low-temperature air separation unit for producing high-purity nitrogen.

Similar A.L. unit for recovering hydrogen from coke-oven gas.

Ketona Chemical, at Birmingham, Alabama, has successfully inaugurated the first ammonia plant in this country designed exclusively around coke-oven gas as a source of hydrogen. The low-temperature gas separation units used at Ketona were designed and built by American Air Liquide.

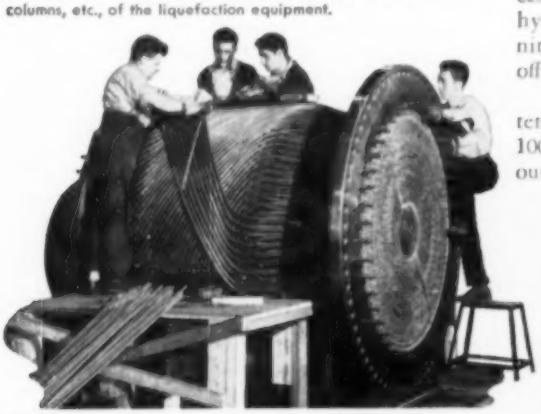


A portion of Air Liquide's Engineering and Construction Division fabricating plant at Montreal, Que. Under fabrication here are numerous all-welded stainless steel shells to house component exchangers, vaporizers, rectification columns, etc., of the liquefaction equipment.

Low-temperature separation processes, for recovering atmospheric and hydrocarbon gases in tonnage quantities, are being used on a rapidly increasing scale in the United States.

Once confined to the separation of oxygen, nitrogen and the rare gases of the atmosphere, the low-temperature liquefaction process of separation is today successfully producing high-purity hydrogen, pure carbon monoxide, methane, ethylene, propane and nitrogen, from such gaseous mixtures as: natural gas, refinery off-gases and coke-oven gas.

During the past 50 years, Air Liquide (a pioneer in the low-temperature gas separation field) has designed and built more than 1000 hydrocarbon and air-separation plants for industries throughout the world. In the United States it is a leader in this field.

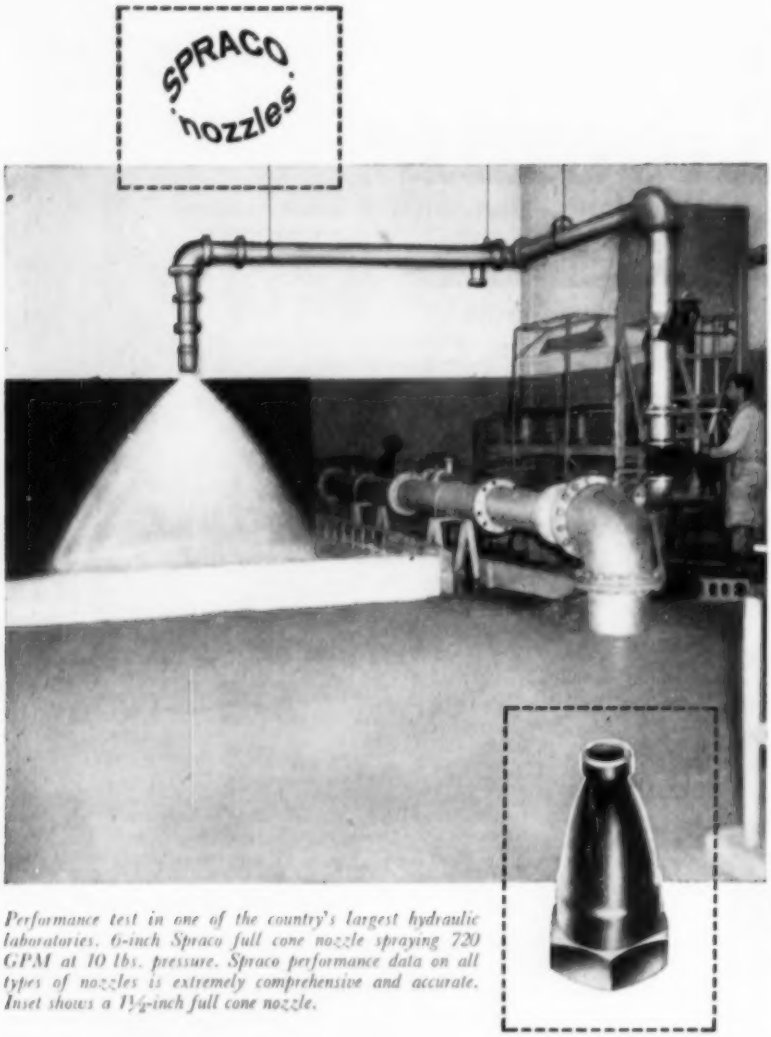


The fabrication of an Air Liquide wound tube-type exchanger can involve over 10 miles of intimately interwoven copper tubing to provide the necessary cooling surfaces in this specialized low-temperature equipment.



Centre of control panel for a large-tonnage oxygen plant includes a flow sheet for the operator's guidance. Once put "on stream", operation of Air Liquide low-temperature plants is almost entirely automatic.

L'Air Liquide, its affiliates and subsidiaries have offices and plants throughout the world: Algeria, Argentina, Belgium, Brazil, Cameroon, Canada, China, Egypt and Sudan, France, French Congo, French West Africa, Gold Coast, Great Britain, Greece, Indochina, Italy, Ivory Coast, Japan, Lebanon, Luxemburg, Madagascar, Malay States, Morocco, Netherlands, Paraguay, Portugal, Siam, South Africa, South-East Asia, Spain, Sweden, Syria, Tunisia, and the United States of America.




*Performance test in one of the country's largest hydraulic laboratories. 6-inch Spraco full cone nozzle spraying 720 GPM at 10 lbs. pressure. Spraco performance data on all types of nozzles is extremely comprehensive and accurate. Inset shows a 1½-inch full cone nozzle.*

# SPRACO
## full cone spray nozzles

**IN STOCK** — the most complete range of sizes and capacities available anywhere.

**IN BRASS, BRONZE, STAINLESS STEEL,** or (on special order) in any machineable metal.

**PATTERN** — uniform, even distribution, — wide angle down to sharp angle.

**REPLACEABLE CORE** — in spraying highly corrosive liquids at high pressures worn cores are easily replaced.

**FLAT SPRAY and HOLLOW CONE SPRAY** nozzlee are also available from stock.



*For complete catalog, Write:*

**SPRAY ENGINEERING COMPANY**

132 Cambridge St., Burlington, Mass.


## INDUSTRIAL NEWS

**"Regretfully abandoned" says American Cyanamid** of their negotiations for acquisition of Norwich Pharmacal Co. Reason: "insurmountable legal problems." □

**Graver Tank & Manufacturing Co. will become a part of the Union Tank Car Co.** of Chicago if the merger of its parent company, Phoenix Manufacturing Co., with Union Tank Car is approved as expected. Graver, now celebrating its 100th anniversary, is a leading equipment supplier to the petroleum, chemical, and nuclear industries. □

**New oxygen production facilities are on stream** at the new plant of National Cylinder Gas Co. in Louisville, Ky. Local distribution of high-purity oxygen for industrial and inhalation therapy use is in full swing. □

**Additional facilities for extrusion and compression of Teflon sheets, rods, tubes, film, gaskets, and packing** will be installed by John L. Dore Co., Houston, Texas. The program, to cost $250,000, will double the company's production capacity. □

**A major expansion of phosphoric acid and phosphate facilities** has just been completed at the Newark, Calif., plant of Westvaco Mineral Products Division of Food Machinery and Chemical Corp. Westvaco is now the largest producer of these materials west of the Rocky Mountains. □

**Production of high-melting point microcrystalline waxes will be accelerated** by new units at the Petrolia, Pa., plant of L. Sonneborn Sons, Inc. The hard waxes, which function as replacements for natural or vegetable waxes, are primarily intended for use in the manufacture of emulsion polishes. □

**A new quality control laboratory has gone into service** at the recently-dedicated $16 million fertilizer plant of the California Spray-Chemical Corp. in Richmond, Calif. □

**The Chicago plant of U. S. Industrial Chemical has been purchased by Mid-America Chemical Terminal,** new subsidiary of DeMert & Dougherty, Inc. The property, which covers 11 acres, will accommodate the aerosol production facilities of Aeropak, Inc., another DeMert & Dougherty subsidiary. □

# 40 Forward Years FOR CROLL-REYNOLDS

**1917** Croll-Reynolds Co. established; work on EVACTORS, started previously by the two founders, now enters new phase.

**1920's** Croll-Reynolds contributes greatly to the power field's efficient use of intercondensers between stages for steam economy.

**1930's** Croll-Reynolds focuses on the need for high vacuum in the growing chemical field—gives special attention to design of 4 and 5 stage EVACTORS, and also to the application of steam jet refrigeration equipment.

**1940's** Croll-Reynolds directs activity toward war effort, supplies a great number of EVACTORS for shipboard use, special units for the atomic program, and equipment for manufacturing new types of explosives and chemicals. **In the late 1940's,** Croll-Reynolds develops and supplies vacuum equipment for vacuum cooling of fresh vegetables.

**1950's** Croll-Reynolds develops special condensing tower used to recover entrained materials and to prevent contamination of cooling water—especially adaptable for deodorizers in the fatty acid and allied industries.

**PRESENT** Croll-Reynolds continues to develop and perfect new kinds of jet and condensing equipment with the knowledge and skill that has enabled the Company to establish an enviable record. In its Forty Forward Years, Croll-Reynolds has—

- Supplied equipment for vacuum cooling of fresh vegetables with a combined **daily** capacity of 2000 cars **each** holding 25,000 to 30,000 lbs.
- Designed and manufactured **all** the commercial vacuum cooling equipment **used** to date in the electrolytic zinc industry of the U. S. and Canada.
- Supplied **more** vacuum cooling systems for the Viscose-Rayon industry than **all other manufacturers combined.**
- Pioneered many new applications of vacuum and vacuum refrigeration.

**Croll-Reynolds Company, Inc. is confident that in the future, as in the past, they will continue to develop new types of industrial jet equipment and improve existing designs.**

CROLL-REYNOLDS

## Croll-Reynolds CO., INC.

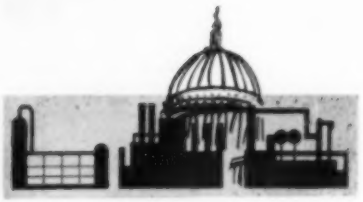
Main Office: 751 Central Avenue, Westfield, N. J.

New York Office: 17 John Street, N. Y. 38, N. Y.

CHILL-VACTORS • STEAM-JET EVACTORS • AQUA-VACTORS • FUME SCRUBBERS • SPECIAL JET APPARATUS

## Recommend vast program for

# INDUSTRIAL USE OF AGRICULTURAL PRODUCTS



**Design and construction of billions of dollars worth of chemical plant and equipment could result from a proposed $100 million annual research program to develop increased industrial use of agricultural products.**

*Joseph L. Gillman, Jr.*

Just released report of a special Government Commission* cites large increases in industrial use of agricultural products as a major solution to the growing problem of agricultural surpluses. Major recommendation: a total of 15 per cent of the annual gross receipts from customs revenues be alloted to a full-scale research program to increase industrial use of agricultural products. In practice this figure would amount to some $100 million.

With the aid of 18 task groups, made up of 188 of the nation's leading agriculturalists, industrialists, and scientists (see box), the Commission has proposed as its first and "most necessary" recommendation that funds for industrial-uses research be increased to not less than three times the amounts currently available, and that additional sums be provided for new crops research, trial commercialization, development, and incentives.

Even though "incentives" are recommended, this is no "plow-the-pig-under" program. It suggests as the long-term objective ". . . the free and efficient utilization by farmers of their land, capital, labor, and managerial resources . . . full, free, and profitable production related to the needs of the Nation."

In setting up the Commission, Congress specifically mentioned "rubber, industrial alcohol, and motor fuels," since these are tonnage products already established as producable from agricultural surpluses. But there are many more products research can develop, and even in those already proven, competitive commercial production is a different matter. Engineering any of the products developed into profitable tonnage materials presents a big challenge to chemical engineers.

Several bills have already been introduced into the Senate and House based on the Commission's report. It is expected that, following urgent farm legislation designed to effect immediate relief, the consideration of the several "Agricultural and Industrial Board" bills will get immediate attention from Senate and House Committees, with prompt favorable action likely during the second session of the 85th Congress.

**CHEMICAL REPRESENTATIVES ENGAGED IN INDUSTRIAL-USE STUDY**

Among the representatives of the chemical industry on the 18 task groups were:

T. S. Carswell, Commercial Solvents
R. E. Chaddock, Hercules Powder
H. R. Duffy, Quaker Oats
J. L. Gunson, Publicker
John Livingston, consultant
W. B. Plummer, consultant
J. A. Reid, Phillips Petroleum
G. W. Rigby, Du Pont
R. G. Ruark, Corn Products
E. R. Weyer, Chas. Pfizer

* Commission on Increased Industrial Use of Agricultural Products set up by the 84th Congress (1954-56): J. L. Welsh (chmn.); K. D. Butler; G. H. Coppers; C. R. Sayre; and F. J. Welch.

**CHEMICAL INDUSTRY EXECUTIVE COMMENTS ON THE COMMISSION REPORT**

P. H. Groggins, Food Machinery & Chemical Corp., has this to say: "An objective review of the proposed program indicates that the Commission did a thorough job. There is, however, the feeling that the Commission credited the researchers with having magic wands. It must be remembered that a large corps of outstanding scientists have been working in this field for many years. . . . The Commission pointed out that synthetics have made great inroads on agriculture in fields that only a few years ago were regarded as natural monopolies of certain crops. There is a good reason for this trend. The synthetics are usually based on a plentiful supply of cheap raw materials having a relatively stable price structure. These raw materials can be efficiently converted to needed articles of commerce.

On the other hand, the job of converting agricultural surpluses such as foodstuffs into new products is mainly uneconomic. It is much easier for research to increase production of foods, feeds, and fibers, than to find new and competitive markets for such agricultural products. According to a former member of Counsel who has had experience in this field, it would appear desirable to use the existing USDA utilization research organization, augmented somewhat with respect to leadership to carry out an appreciably enlarged research program. An evolutionary rather than a revolutionary expansion appears desirable."

### Research vs. Storage Costs

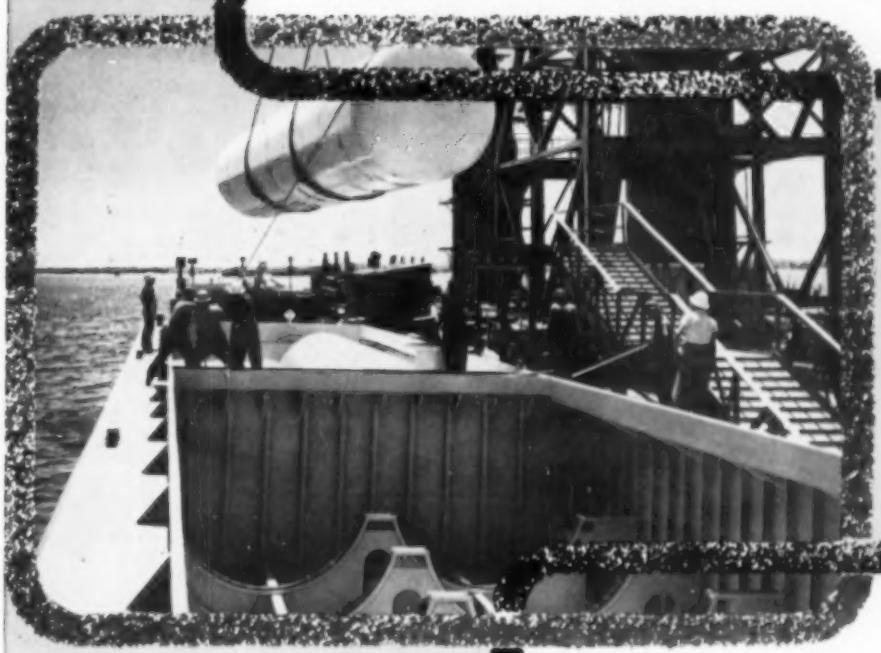
$100 million a year is a lot of money, vastly exceeding even Du Pont's research budget. But it should be remembered that $100 million pays for only four months storage of surplus commodities. As agronomist W. F. Watkins, Olin Mathieson's assistant manager of Government Services, says, "If we can learn through research under this proposed program how to controlably release a reasonable portion of the energy stored in farm crops now produced in excess of our needs, the Government will be amply repaid for its investment."

### Who Will Administer?

A five-man Agricultural Research and Industrial Board is recommended by the Report—but what bureau or agency will have control over this Board? The Commission made two alternative suggestions: an independent non-partisan Board appointed by the President with the advice and consent of the Senate; or coordinate all agricultural research in the Depart-

(*Continued on page* 102)

**INGALLS** again builds specialized barges...
this time for CHLORINE!



From The INGALLS Shipbuilding Corporation has come a long and impressive line of "specialized barges for specialized purposes" . . . special acid barges, oil barges, special cement barges, unique chemical barges designed to transport 300° F. molten sulphur . . . *and now . . . in addition to these,* INGALLS *has constructed two chlorine barges . . . designed to safely transport liquefied chlorine.*

These remarkable barges were built by INGALLS for Diamond Alkali Company to withstand pressures of up to 300 lbs. per square inch. They are equipped with a system of relief valves and other necessary devices that meet all requirements of the U. S. Coast Guard and the A.B.S.

Regardless of the size or specifications of your barge . . . whether it be large or small, specialized or conventional . . . *consult* INGALLS *first!*

**Specialists in marine repairs**

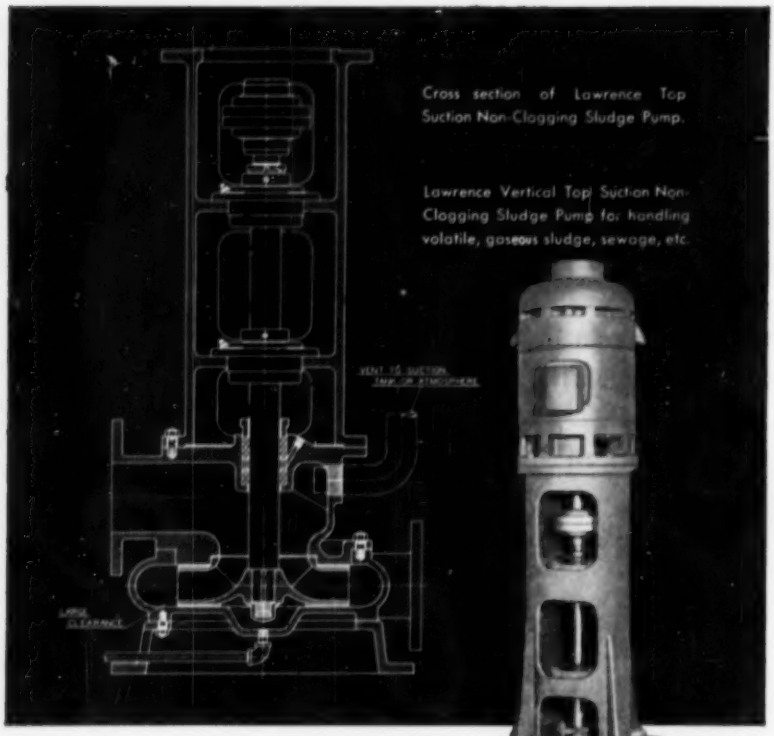
INGALLS is equipped and staffed to competently handle all types of marine repairs. Write or phone for information today.

THE **INGALLS** SHIPBUILDING CORPORATION

*Executive Offices:* Birmingham, Alabama
*Branch Offices:* New York, Washington, New Orleans, Chicago, Philadelphia, Atlanta, Houston
*Shipyards:* Pascagoula, Mississippi; Decatur, Alabama
*Subsidiary:* Arnold V. Walker Shipyard, Inc., Pascagoula
*Complete Dry Docking Facilities at Ingalls Decatur yard*
*Additional Marine Ways at its subsidiary, the Arnold V. Walker Shipyard, Inc., Pascagoula, to handle all types of repair work*

**DESIGNERS & BUILDERS** of Offshore Service Vessels, Commercial and Drilling Barges, Tankers, Naval, Merchant Vessels

**ENGINEERS:** For jobs with a future, contact INGALLS today




**PUMP** *volatile*

**SLUDGES AND SLURRIES**

*...without clogging*
*...under a low net positive suction head (NPSH)*
*...without gas or vapor binding*

The Lawrence Non-Clogging Top Suction Pump is designed specifically to handle volatile sludges and slurries. Large clearances through the impeller and casing completely prevent clogging. Volatile gases or vapors liberated at the impeller entrance (the point of lowest pressure), are pushed up and out of the way and can be vented back to the suction tank or exhausted to atmosphere.

This type of pump can operate with a very low Net Positive Suction Head (NPSH) and never become gas or vapor bound. It is made in all metals and alloys such as: — cast iron, bronze, stainless steel, Hasteloy, etc. — depending on the material pumped.

For further details on Lawrence Non-Clogging Slurry and Sludge Pumps write for Bulletin 206-4.





**LAWRENCE PUMPS INC.**
371 Market Street, Lawrence, Mass.


## AGRICULTURAL PRODUCTS

*(Continued from page 100)*

ESTIMATED RESEARCH OBLIGATIONS OF DEPARTMENT OF AGRICULTURE
(In Thousands of Dollars)

| | 1957 | 1958 |
|---|---|---|
| Production Research | $47,853 | $53,571 |
| Utilization Research | | |
| New and Improved Uses | | |
| Farm Products | 12,321 | 14,297 |
| Forest Products | 1,956 | 2,225 |
| Sub Total | 14,277 | 16,522 |
| Home Economics | 1,840 | 2,183 |
| Total, Utilization Research | 16,117 | 18,705 |
| Marketing Research | 9,180 | 10,773 |
| Total Research by USDA Agencies | 73,150 | 83,049 |
| Payments to States | 29,504 | 34,004 |
| TOTAL FEDERAL FUNDS FOR RESEARCH | 102,654 | 117,053 |

ment of Agriculture, under a director with the title of Assistant Secretary, in which case the Board would be appointed by the President but would be responsible to the Secretary of Agriculture.

Those close to the Department of Agriculture feel definitely that the existing Agricultural Research Service of the Department should be expanded to meet the proposed requirements and to have full jurisdiction over the disposition of the appropriated funds.

Those close to industry feel that the problem is too broad to be handled by one existing Government bureau, want a Board with the flexibility and authority to solicit and secure the active aid of all necessary Government agencies.

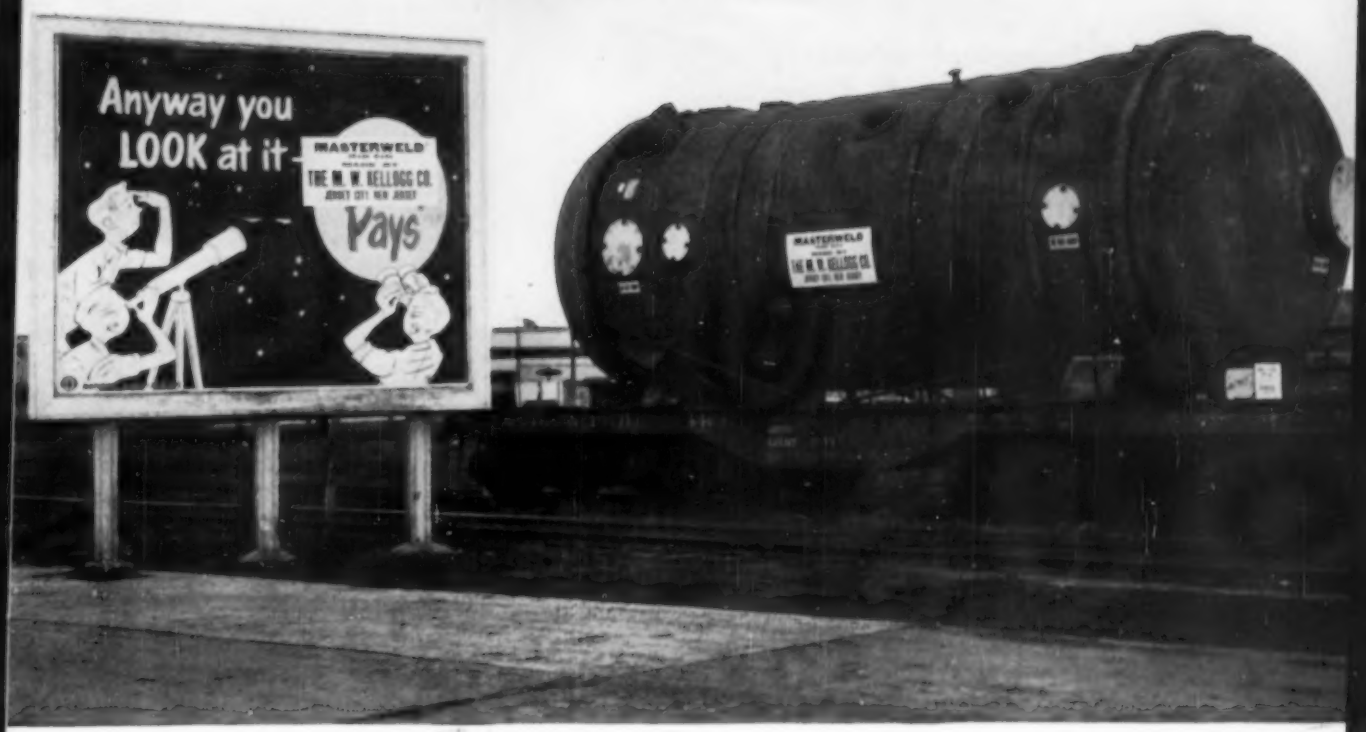
Strongest argument against placing the new Board under the Department of Agriculture came at the recent hearing before the House Subcommittee on Research and Extension of the Committee on Agriculture. There, T. G. Abernethy (*D.-Miss.*), chairman of the subcommittee, observed, "If this proposed Agricultural Research

*(Continued on page 104)*

## CORRECTION

In Mr. Gillman's report on p. 68 of the August *CEP*, it was erroneously stated that H.R. 7963 had been passed and signed by the President. This should have read that Bill S-2504 had been passed and signed keeping the SBA alive as a temporary agency. Bill H.R. 7963 is still pending.

# Pride that Pays Off




Kellogg's plant people at Jersey City showed justifiable pride in their work when they modified this familiar sign in the company's railroad siding.* On its way to a major chemical company, the Masterweld unit is one of the largest heat exchangers ever built. Whether your heat transfer requirements need specially designed giants like this or standard type units, the personal pride of Kellogg's personnel in their designing, engineering, and fabrication pays off in longer and more satisfactory service for Kellogg's customers.

KELLOGG

**FABRICATED PRODUCTS DIVISION**

## THE M. W. KELLOGG COMPANY

**711 THIRD AVENUE, NEW YORK 17, N. Y.**

A SUBSIDIARY OF PULLMAN INCORPORATED

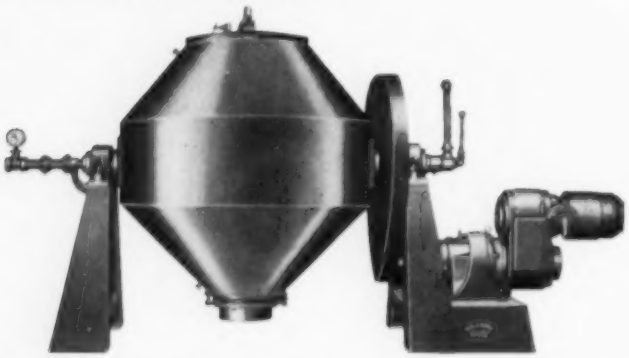
*The Canadian Kellogg Company Limited, Toronto • Kellogg International Corp., London • Kellogg Pan American Corp., New York*
*Societe Kellogg, Paris • Companhia Kellogg Brasileira, Rio de Janeiro • Compania Kellogg de Venezuela, Caracas*

* With apologies to National Safety Council Inc. for the temporary defacement

PAUL O. ABBÉ'S

*New*
ROTA-CONE
VACUUM
DRYER

***Brings important advances to Batch Drying of a multitude of industrial products***



COMPLETELY JACKETED & INSULATED—
economy of high thermal efficiency.
—safety of low temperature.
—even heating & drying.

VACUUM DRYING—
—Volatile solvents are condensed & recovered.
—noxious vapors are easily controlled.

UNIQUE TUMBLING ACTION—
—no layering or caking.
—even drying of all particles.

COMPLETELY SEALED—
—Dustless, odorless, *clean* operation.

SMOOTH, CLEAR INTERIOR—
—No internal agitators to abrade or fracture delicate material particles.
—quickly cleaned for material change-over.

**You'll find the new Rota-Cone the most profitable machine to use in many batch-drying operations.**

**PLUS FEATURE:—is Rota-Cone's ability to dry safely many materials previously considered too delicate for production drying.**

**The Rota-Cone is available in sizes ranging from 0.1 to 325 cu. ft. operating capacity.**

*Write for Folder "C," containing specifications.*

PAUL O. ABBÉ INC.

**271 Center Avenue** **Little Falls, New Jersey**

## INDUSTRIAL NEWS

**Construction of an acrylonitrile plant** is scheduled for early next year at Dow Chemical's Texas Division in Freeport. Slated for completion in December, 1958, the plant is expected to go on stream in the first quarter of 1959. □

**New chemical process for treatment of lithium ore flotation concentrates** is under investigation by Montgary Explorations Ltd., Toronto. The Canadian firm, which recently announced ratification of an option agreement with American Metal, has proved reserves of 8,000,000 tons of spodumene averaging 1.85% $Li_2O$ at their Bernic Lake, Manitoba, property. Bonus feature of the development may be by-product cesium, also present in some of the spodumene deposits. □

**Hammond, Indiana, will be site of new 400 ton-per-day sulfuric acid regeneration plant** to process refinery sludge acids. Stauffer Chemical, who will put up the $4,000,000 unit, expects full-scale production by next July. □

**Production of Nylon-6 has started** at the new Henderson, Kentucky plant of Spencer Chemical. The process used is licensed from Onderzoekingsinstituut N.V. of Arnhem, Holland, involves polymerization of caprolactam. □

## AGRICULTURAL PRODUCTS

*(Continued from page 102)*

and Industrial Board is placed within the Department of Agriculture, the strong probabilities are that nothing will be done. The Department is production minded. Production researchers have for years dominated the Department's research activities. They will absorb the Board within existing framework and will either utilize the additional appropriations for more production research, or will relegate industrial and utilization research to a secondary position." Apparently, Rep. Abernethy favors an independent Board, fears the possible "go slow" research of the Agriculture Department.

But P. H. Groggins, Food Machinery and Chemical (see box) takes a different view—". . . it would appear desirable to use the existing USDA utilization research organization . . . an evolutionary rather than a revolutionary expansion appears desirable."

## World's Largest Sea Water Salt Plant Proves Crane Valve Quality



### Three times longer valve life on corrosive weak brine

Before Leslie Salt Co. changed to Crane diaphragm valves here in its Newark, Calif., plant, lubricated plug cocks were causing constant maintenance. The highly corrosive condensate and weak brine solution being handled pitted the plugs, started leakage, and forced replacement of the cocks every 2 years.

To date, the Crane neoprene-lined diaphragm valves have already given 3 times longer service than the cocks. In these valves, the diaphragm isolates the working parts from line fluid, and the neoprene lining protects the disc and body. Result: after 6 years of cost-free usage, the Crane valves are still seating tightly with easy operation.

Valve performance like this can only come from correct design, better materials, precision assembly, and thorough testing—features you cannot detect from outside appearance. Why gamble with your valves and fittings? Specify Crane and be sure of top-quality flow control.



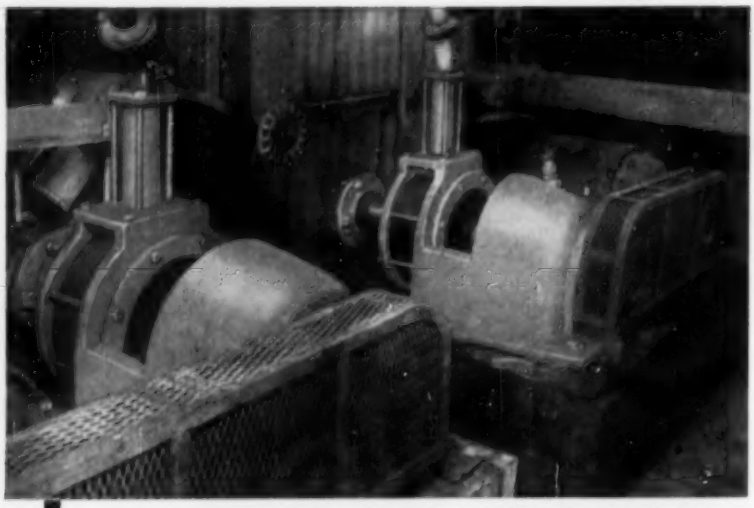

Get Crane Folder AD-1942 on packless diaphragm valves. See your Crane Representative for a copy, or write Crane Co., address below.

# CRANE VALVES & FITTINGS

**PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING**

*Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas*

# Imperwite IMPERVIOUS GRAPHITE Chemical Pumps

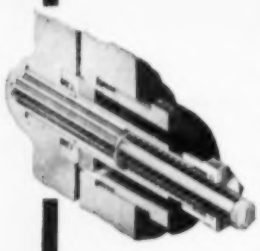


## ...REDUCE COSTS at Durez Plastics Division Hooker Electrochemical Co.

Fourteen IMPERVITE chemical pumps are in operation at the North Tonawanda plant, handling hot mixtures of phenol, chlorobenzene, and benzene as well as hot and cold muriatic.

Under conditions of continuous operation, these pumps may run for months with no maintenance other than an occasional adjustment of the seal adjusting nut.

Mr. Littler, Maintenance Engineer for this plant, states, "Over the past 3 months, the total expense for material and labor on *all* of these IMPERVITE pumps was only $23.00."



VIRTUALLY LEAK PROOF IMPERVITE PUMP SEAL

IMPERVITE chemical pumps are single stage centrifugals, and utilize a new self-cooling and self-lubricating seal which is virtually leakproof. Six standard models are available from stock, and specials are furnished in capacities to 1000 gpm.




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PHONE: CHurchill 8-5357
TELETYPE: SOLON 0-720
31911 AURORA ROAD • SOLON, OHIO


## INDUSTRIAL NEWS

**Aluminum powder metallurgy products are commercially available in the United States for the first time.** The new products, made by Aluminum Co. of America, are said to permit high-temperature applications impossible with conventionally-produced alloys, some can withstand temperatures above 900° F. Immediately available are extruded shapes, forgings, sheet, foil, drawn and extruded tube, impact extrusions, fasteners, and wire. □

**108 million pounds per year of aluminum in 1958** is the goal of the new aluminum reduction plant of Harvey Aluminum at The Dalles, Ore. On the Columbia river 82 miles east of Portland, the plant will use more than 100,000 tons per year of alumina from Japan. □

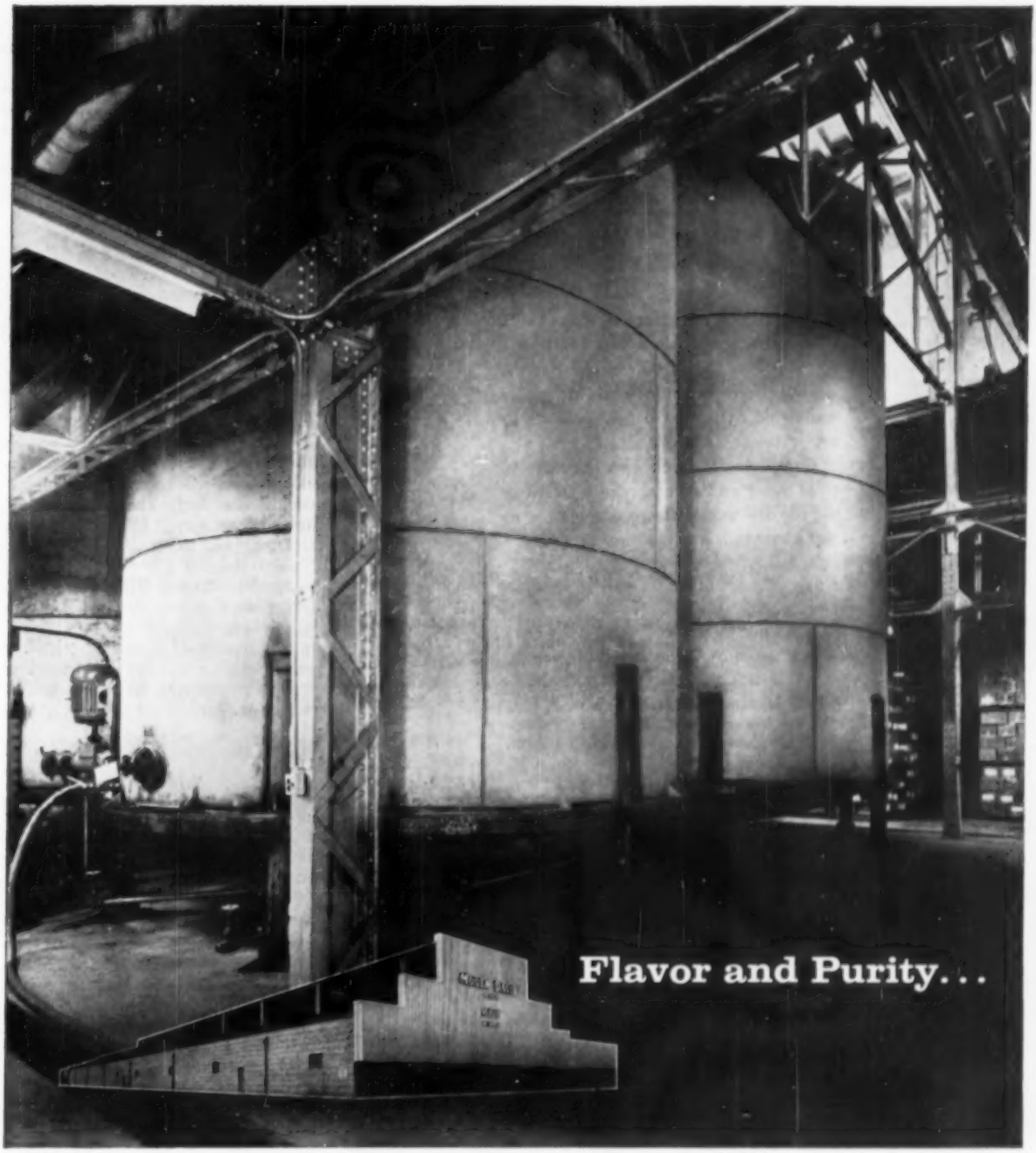
**Largest industrial order for fabricated titanium in the history of the industry** is seven miles of seamless titanium pressure tubing for a chemical process application. Supplier is Titanium Metals Corp. of America. User will be Freeport Sulphur Co. in their under-construction nickel-cobalt plant at Moa Bay, Cuba. The tubing, to be extruded in 2,130 sections, each 17½ feet long, will be used in eight kettle-type heat exchangers employed in processing nickel and cobalt ore. □

**10,000 tons per year of urea will be produced by Hercules Powder** in new facilities at their Hercules, Calif., plant. Construction will start immediately, completion date is set for late 1958. □

**A wholly-owned Canadian subsidiary has been organized by Leeds & Northrup Co. of Philadelphia.** The new firm, Leeds & Northrup, Canada, Ltd., will manufacture and distribute electronic controls and measuring instruments formerly supplied from the United States. □

**Additional facilities just put on stream at the Stauffer Chemical petrochemical** project, Louisville, Ky., are producing two new products: chloroform and methylene chloride—as well as additional quantities of carbon tetrachloride and hydrogen chloride. □

**New member of the growing Pittsburgh industrial community is Callery Chemical,** which will move its administrative and sales offices from Callery, Pa., to a new building at Commodore Perry Square, Pittsburgh. □




## ASSURED BY 15 SITE-ERECTED STAINLESS TANKS

Half a million gallons of Mogen David Wine Corporation's popular Key wines are blended and stored in 15 stainless tanks site-erected by Graver at Chicago's newest winery. Graver crews erected four tanks, 18'6" diameter x 28'6" high, and eleven tanks, 14' diameter x 18'3" high, all of Type 304 stainless steel. By the selection of stainless steel, the distinctive flavor of 3 entirely different Key Wine brands is maintained consistently during storage and blending. If flavor and purity are factors in your product, be sure to consult with Graver engineers.

ALLOY DIVISION

1857-1957 GRAVER Our 100th Year

GRAVER TANK & MFG. CO. INC.

EAST CHICAGO, INDIANA • NEW YORK • PHILADELPHIA • EDGE MOOR, DELAWARE
PITTSBURGH • DETROIT • CHICAGO • TULSA • SAND SPRINGS, OKLAHOMA
HOUSTON • NEW ORLEANS • LOS ANGELES • SAN FRANCISCO • FONTANA, CALIFORNIA

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AMMONIUM SULPHATE • ANTIBIOTICS • BAKING COMPOUNDS • BANANAS
BARIUM TITANATE • BLOOD • CALCIUM ACETATE • CALCIUM BUTYRATE
CALCIUM PHOSPHATE • CALCIUM [illegible]ATE • CALCIUM SILICATE • CARBON
CATALYST • CERAMICS • [illegible]HEESE • COCOA • COFFEE
CLAY • COPPER • COP[illegible] ALAPON • DETERGENTS
DYES • EGGS • EGG[illegible] [illegible]YMES • FORMALDEHY
FLAVORINGS • F[illegible] GELATINES • GLUE
HERBICIDES • IR[illegible] OXIDE • SULPHATE
LIVER EXTRACTS[illegible] [illegible]UM CARBONATE
MAGNESIUM S[illegible] [illegible]ALT EXTRACTS
MELAMINE-FO[illegible] K • MOLASSES
PAPRIKA • PE[illegible] I • PENICILLIN
PHENOL-FOR[illegible] • PIGMENTS
PLOY STYRE[illegible] POLY VINYL
CHLORIDE [illegible]ARBONATE
PHOSPHA[illegible] [illegible]CHARATE
MAGNESI[illegible] STYRENE
ACETATE [illegible]RBONATE
DETERGEI[illegible] [illegible]TTERMILK
SODIUM I[illegible] [illegible]GICIDES
SILICATE • [illegible] E LIQUOR
SULPHIDE [illegible]IONATES
STICKWA[illegible] [illegible]ITANIUM
TOMATOE[illegible] SULPHIDE
BENZOATI[illegible] DIOXIDE
CARBONA[illegible] [illegible]OTASSIUM
GELATINE • [illegible] CHLORIDE
SULPHIDE [illegible] [illegible]AGNESIUM
COMPOUN[illegible] • TITANIUM
MOLASSES • [illegible] [illegible]PHOSPHATE
CALCIUM • C[illegible] [illegible]YES • EGGS
FLAVORINGS [illegible] HERBICIDES
IRON OXIDE • [illegible] ER EXTRACTS
PENICILLIN • PL[illegible] POLY VINYL
ACETATE • POL[illegible] [illegible]PHATE • SOAP
PHOSPHATE • SO[illegible] [illegible]ULPHIDE WASH
WHEY • YEAST [illegible] HYDROLYSATES
CARBONATE • MA[illegible] [illegible]DIUM • PROTEINS
SODIUM CHLORIDE [illegible] WETTING AGENTS
PAPRIKA • PECTIN • [illegible] IRON SULPHATE

SPRAY DRYING

Experience...

at your service

Nerco-Niro engineers offer the skills and equipment developed as the result of world-wide experience in drying both organic and inorganic materials . . . from a few pounds to many tons per hour.

Complete facilities with laboratory, pilot plant and commercial size spray dryers are available to our clients at our plant in Netcong, New Jersey.

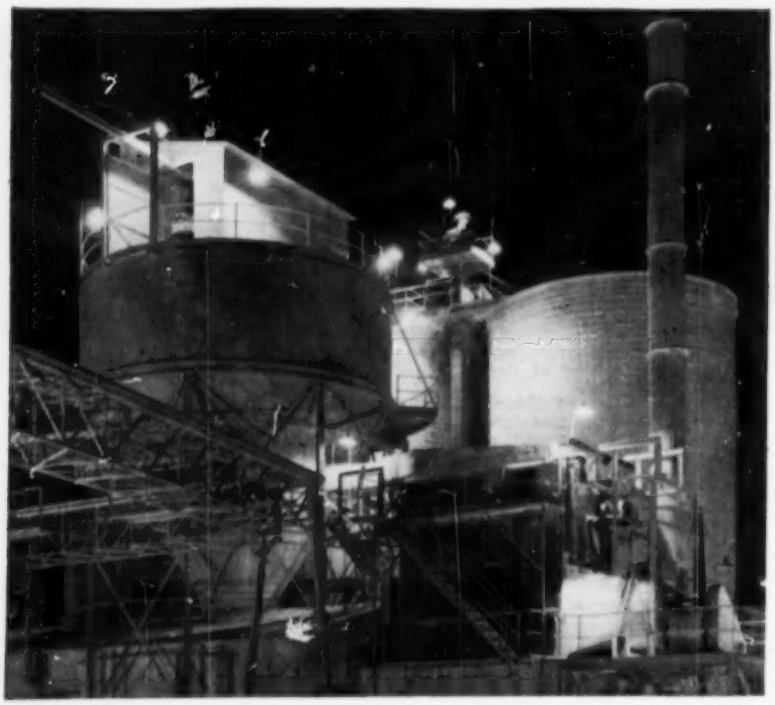
*Write for Bulletins.*

**Nichols Engineering & Research Corp.**

*Nerco-Niro Spray Dryer Division*

70 PINE ST., NEW YORK 5, N. Y.

1637 N. Illinois St., Indianapolis 2, Ind.
1477 Sherbrooke St. W., Montreal 25, Canada
405 Montgomery St., San Francisco 4, Calif.



*Below: Large Nerco-Niro spray drying installation.*

## OVERSEAS NEWS

**World-wide services to industry in the field of engineering, design and construction** will be offered by the new international firm of Laing-Ferguson. Having its headquarters in London, England, the new firm is an association between the H. K. Ferguson Co. of Cleveland, and John Laing & Son Limited of London. Laing-Ferguson's complete services, which will be executed under a single responsibility, will include everything from industrial plant site location and preliminary engineering through detailed design, construction and equipment installation, to plant start-up. □

**A company to manufacture acrylic fiber in Japan is being formed by the Chemstrand Corp. and Mitsubishi Rayon Co., Ltd.** The new firm will manufacture acrylic fiber under license from Chemstrand. To be known as Shinko Acrylic Fiber Co., the new company will have Mitsubishi as majority stockholder. Production start-up is planned for 1959 with an initial rated capacity of 7,500,000 pounds a year. Later expansion is planned to bring the capacity up to 15 million pounds a year. □

**A new European subsidiary,** Tracerlab (Holland) N.V. has been established by Tracerlab, Inc. of Boston, Mass. Main function of the new branch will be the distribution of radiation instruments in the European market. □

**A new corporation with U. S. and Belgian industrial ownership, NDA Europe,** has been formed in Brussels to provide for rapid atomic energy development in the six Euratom countries, their colonies and territories. Principal owners of NDA Europe are Nuclear Development Corp. of America and Societe Generale des Minerais of Brussels. Societe Belge pour l'Industrie Nucleaire is also a participant. □

**Blaw-Knox, Chemical Plants Division, has been retained to conduct an engineering study of two South American chemical facilities,** and to recommend a modernization and improvement program for the owners. The plants are owned by Anglo-Lautaro Nitrate Corp. and are located at Maria Elena and Pedro de Valdivia, Chile. In addition to the modernization survey, Blaw-Knox will design a new $1.5 million sodium sulfate plant for the company at Coya Sur, Chile. □

# Deep in the Earth There's Another Reason Layne's on Top!

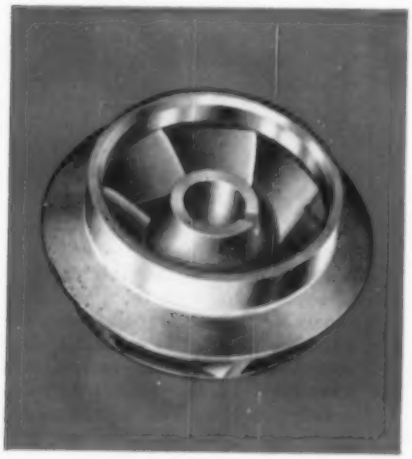
THE LAYNE IMPELLER is that reason, because a pump can be no better than its impeller.

There are two main considerations in impeller evaluation—QUALITY AND PERFORMANCE.

QUALITY—The materials used in the manufacture of a Layne impeller must be tough, durable and possess excellent *surface quality* and they must be able to insure *dimensional accuracy*. Metal patterns are used in casting high quality phosphor gear bronze into Layne impellers. Other special metals are specified when necessary.

PERFORMANCE—A Layne impeller is correct in hydraulic design based on 75 years of Layne experience through thousands of successful installations and tests. Correct impeller design determines a pump's performance in any particular hydraulic condition.

Each Layne impeller is precision manufactured. Because no one technique is adequate, both hand finishing and special machining are used in balancing and tooling the impeller. Working to a rigid and minimum tolerance, specially designed gauges and instruments check each step to the finish of a Layne impeller . . . from water passages and angles to vane thickness.



Layne Impeller sizes range from 4" diameter and up, as specified.

The result — an impeller which operates deep in the recesses of the earth dynamically in balance. Each remaining component part of a Layne pump receives the same careful engineered attention, and when assembled assures complete pump perfection giving you years of trouble-free service.

*Layne's 75 years of experience puts Layne on top!*



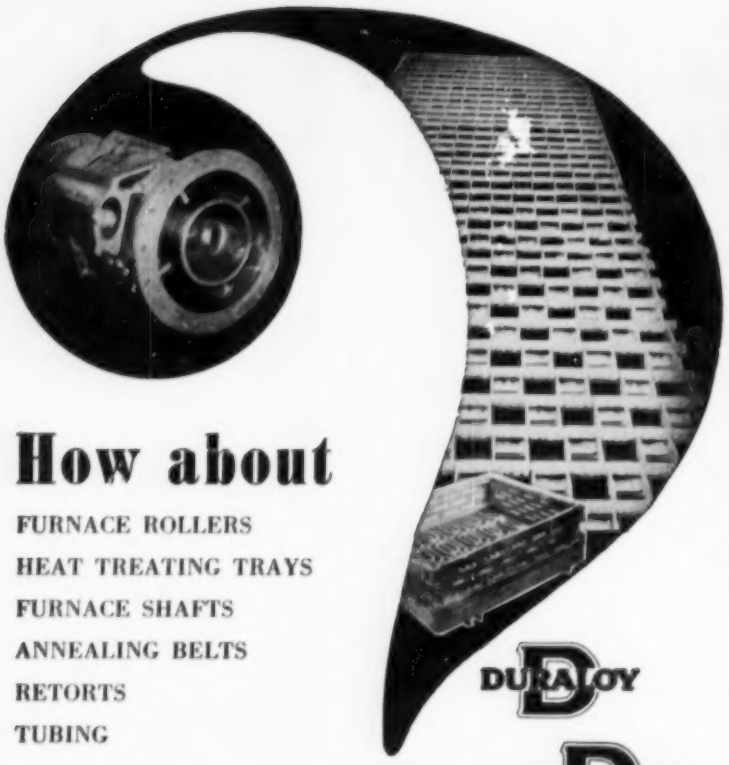

1882 — 1957
Layne
75 YEARS OF PROGRESS

WATER WELLS • VERTICAL TURBINE PUMPS • WATER TREATMENT

**LAYNE & BOWLER, INC. MEMPHIS**

General Offices and Factory • Memphis 8, Tennessee

LAYNE ASSOCIATE COMPANIES THROUGHOUT THE WORLD



# How about

FURNACE ROLLERS
HEAT TREATING TRAYS
FURNACE SHAFTS
ANNEALING BELTS
RETORTS
TUBING

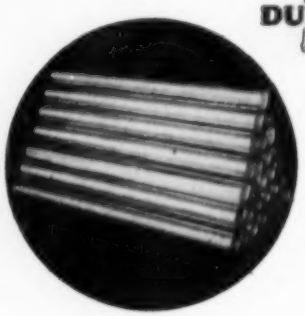
DURALOY

DURASPUN

Which are
**Heat Resistant**

**Corrosion Resistant**

**Abrasion Resistant**

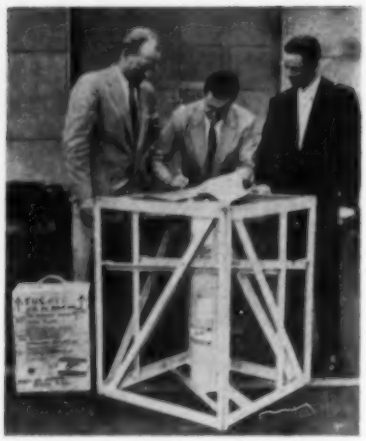


**When ready to order, how about checking with us here at DURALOY? For more than thirty years we have specialized in high-alloy castings. In fact, we were among the first to produce static castings and the first to produce centrifugal castings. We are old hands at producing castings alloyed to fit each specific requirement and to finish them to any extent desired.**

**Melt, castings and finishing are carefully controlled and quality tested by our staff of metallurgists, chemists, X-ray and gamma ray technicians. If you would like more preliminary information, send for Bulletin No. 3354-G.**

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
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ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.


## OVERSEAS NEWS



First shipment of uranium to West Germany took place July 23, when A.E.C. released 1,800 grams of U-235 to a German representative at Idlewild Airport, New York. The material, valued at $7,500 was released under an Agreement for Cooperation signed in April, 1956.

**Whessoe, Ltd., Darlington, England, one of the world's largest producers of steel storage tanks and refinery equipment, will manufacture a new line of electrical remote control and supervisory equipment** for the petroleum, chemical, and chemical processing industries under license from Shand and Jurs, Berkeley, Cal., developer of the new equipment. Whessoe will sell in the United Kingdom, and will cooperate with Shand and Jurs, a subsidiary of General Precision Equipment Corp., N. Y., in markets outside the continental United States. □

**A group of eleven top Guatemalans, in cooperation with the Point Four program, recently visited The Pfaudler Co.,** Rochester, N. Y. Their visit was part of a program to study labor-management relations, executive development programs, and increasing productivity. □

**Polystyrene plastic plant, first in Middle and Southeast Asia,** is on the line in Bombay, India. Co-owners are Polychem Ltd. (formed in 1955 by Dow Chemical who furnished know-how and technical assistance) and Kilachand Devchand & Co., an Indian firm. □

**Eight new foreign patents have just been granted in Italy and Spain to Firestone Tire & Rubber** on methods for production of "Coral" rubber, said to equal or excel natural rubber in many industrial applications. □

# Corrosioneering News

Quick facts about the services and equipment available to help you reduce corrosion and processing costs.

*Published by The Pfaudler Co., Rochester, N.Y., U.S.A.*

## New, more compact drive . . . power is higher, agitation range wider

When you can increase the load carrying capacity of a drive without increasing its size, you get at least three extra advantages. You get a wider range of agitation speeds, a compact unit that leaves surrounding area more accessible, and you eliminate cumbersome supports.

All this we have done with our new Type "W" Drives.



This 2.5W Drive is equipped with stuffing box. Can also be used with rotary seal. Hydraulic drives of the new design are available for 100% explosion-proof construction and wide, variable-speed range.

### Carry greater loads

These new drives handle heavier loads than any other type of comparable worm gearing. They have what is called a "throated" design—both gear and worm teeth have convex arc shapes—which allows more teeth to mesh simultaneously.

### More compact

Notice that the motor is mounted out of the way *above* the drive. This eliminates angular bracing from the top head, permitting a greater number of top head openings. These openings are more accessible and give great flexibility to top head layout . . . particularly valuable features on smaller reactors. (Side mounted motors are available where headroom is limited.)

### Hydraulic, explosion-proof drives available

When you want 100% explosion-proof construction and wide, variable-speed range, you can specify hydraulic drives. These can be supplied at the factory or substituted for existing drives in your plant, by converting with hydraulic motors.

The new drives can also be furnished with double reduction gearing and flange-mounted motor. This provides a totally enclosed gear drive with agitator speeds from 525 to 7.3 RPM in 27 increments.

### Complete flexibility

You can use the new "W" Drives with stuffing box or mechanical seal on both glassed and stainless steel reactors.

Standard 2.5W, 3W, 4W, and 5W Drives are equipped with constant speed sheaves with static-free belts that can be combined to give any required speed for the agitation you desire.

Complete data on design and performance are in Bulletin 951. Check the coupon for a copy.

## New service: customer advisory board reviews Pfaudler designs



The best way to give a customer what he wants is to ask him. Pfaudler did just that by inviting a representative group of management engineers from leading chemical processing plants to appraise design aspects of their standard equipment.

Particularly in the areas of plant hookup, operation, and maintenance, the experience these men have derived from using our equipment complements nicely our design, manufacturing, and field service experience.

The first of the annual meetings of the board was held in May of this year and the commentary more than met our expectations. You will see tangible evidence of the Advisory Board's suggestions in our exhibit at the 26th Exposition of Chemical Industries (December 2-6, New York City).

The Advisory Board is an extension of our continuing efforts to encourage intercommunication between our own personnel and customers. Pfaudler Corrosion Seminars and Maintenance Seminars are still other facets of this program.

We are, of course, always happy to receive your individual suggestions as to how we can serve you better.



Another way of using glassed pipe—jacketed and unjacketed—is in the form of heaters and coolers. Over 10,000 feet were used in making up these polymer heaters and coolers.

## Glassed pipe, fittings, valves, vital links in preventing corrosion

Getting materials to and from process equipment presents numerous areas of possible contamination and corrosion. This is why Pfaudler glassed pipe, fittings, and valves make worth-while additions to your corrosion-free reactors, heat exchangers, columns, etc.

The glass in Pfaudler pipe, fittings, valves and accessory equipment is identical to that used on Pfaudler reactors and tanks—resistant to wide range of acid and alkali corrosion and economically justified.

The smooth surface of glass also minimizes friction, speeding up product movement. Cleaning is simplified.

Standard flanged glassed pipe and fittings are available in diameters from 1½" to 12" I.D. for temperatures up to 400° F. and 150 psi. Outlet, safety, diffuser and line valves will also handle a comparable range of temperatures and pressures.

THE PFAUDLER CO.
Dept.CEP-97, Rochester 3, N. Y.

Send me bulletins checked: ☐ Bulletin 951, Type "W" Drives ☐ Bulletin 886, Glass Lined Pipe, Fittings and Valves ☐ Bulletin 947, Pfaudler Buyer's Guide.

Name ..... Title .....

Company .....

Address .....

City ..... Zone ..... State .....

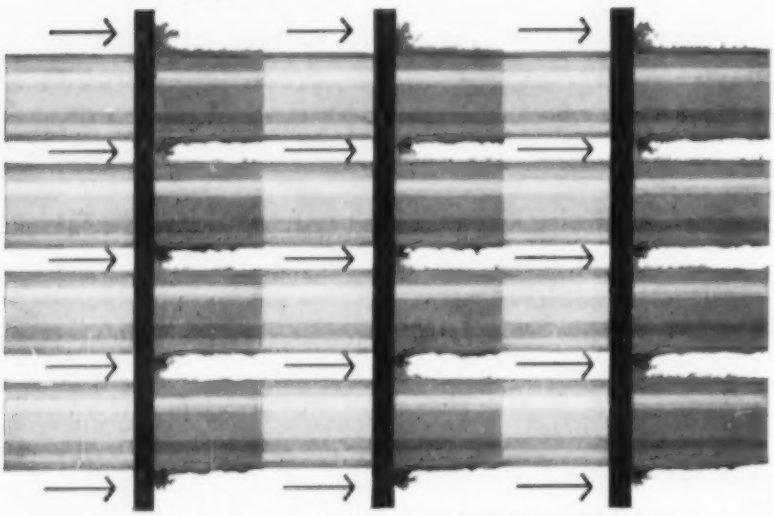
# How a Paracoil "clean shave" gives you better heat transfer

Back and forth go the baffles . . . like blades . . . along the tube surfaces . . shaving away accumulations of fouling materials . . cleaning the heat exchanger . . . and giving process plants continuous, increased and better heat transfer.

This is the unique and principal feature of the Paracoil Self-Cleaning Heat Exchanger. Engineered with movable baffles, operated manually or by timed and automatic motor drive, stationary tubes are scraped and "shaved" free of fouling materials which are then carried away in the liquid.

**The Paracoil Self-Cleaning Heat Exchanger eliminates the need to stop processing for cleaning purposes.**

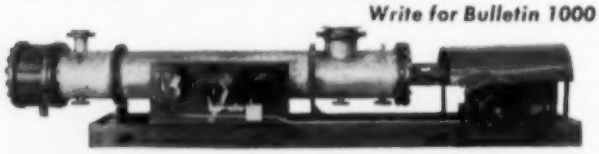
If you have a fouled heat exchanger problem, we may have the answer.



*Davis Makes it — Better!*

Below: Paracoil Vegetable Oil Chiller for converting a batch process to continuous cycle operation. Constructed of stainless steel and with an automatically timed, self-operating, self cleaning baffle assembly. The unit is presently improving product quality and rate of production in a vegetable oil processing plant.

***Write for Bulletin 1000***



**DAVIS ENGINEERING CORPORATION**

30 Rockefeller Plaza, New York 20, New York • Circle 6-5650


## OVERSEAS NEWS

**A plant to manufacture ethylene oxide derivatives is in the planning stage at Fawley, England, by Union Carbide.** Fawley is located on Southampton Water, seven miles southeast of Southampton. Esso Petroleum Company, Ltd., which operates a refinery nearby, will supply the new plant with ethylene. Operations are scheduled to begin in 1959, production capacity will be 45 million pounds a year. Facilities will include installations for the production of ethylene oxide, ethylene glycols, polyethylene ethers, ethanolamines, glycol ethers, and specialized products including polyglycol ethers, polyglycol esters, and other surface-active agents. Engineering studies have been completed and plant design is now in its final stages. The Fawley plant is the second major petrochemicals facility under construction in the United Kingdom by Union Carbide. The first, a 24 million pound a year polyethylene plant at Grangemouth, Scotland, is scheduled for completion in October, 1957. □

**Full-scale atomic power plants will be built in Italy by Fiat, S.P.A.,** under license from Westinghouse Electric International Co. Fiat will be authorized to sell atomic equipment outside Italy as well as within the country. This agreement supplements an earlier Westinghouse arrangement with Ateliers de Constructions Electriques de Charleroi, large Belgian electrical manufacturer. Both foreign firms will have access to design information for the production of atomic equipment for land, marine, and aviation use, including fuel elements, reactor cores, and auxiliary apparatus. Engineering and operating personnel will be trained by Westinghouse. □

**Bone-dry Bahrain Island in the Persian Gulf now has 5,000 gallons of fresh drinking water daily.** Trick was turned by installation of an ion-exchange membrane water desalting unit made by Ionics, Inc., Cambridge, Mass. (See *CEP*, April, 1957, page 190, for technical details of system.) □

**Offices have been opened in Havana, Cuba,** by the Latin American subsidiary of Roger Williams Technical & Economic Services, Princeton, N. J. The subsidiary, same name as the parent company, will carry out consulting chemical market research and economic studies throughout Latin America. □

**$80.00 SAVED**

**EVERY DAY IN**

**MAN HOURS ALONE**

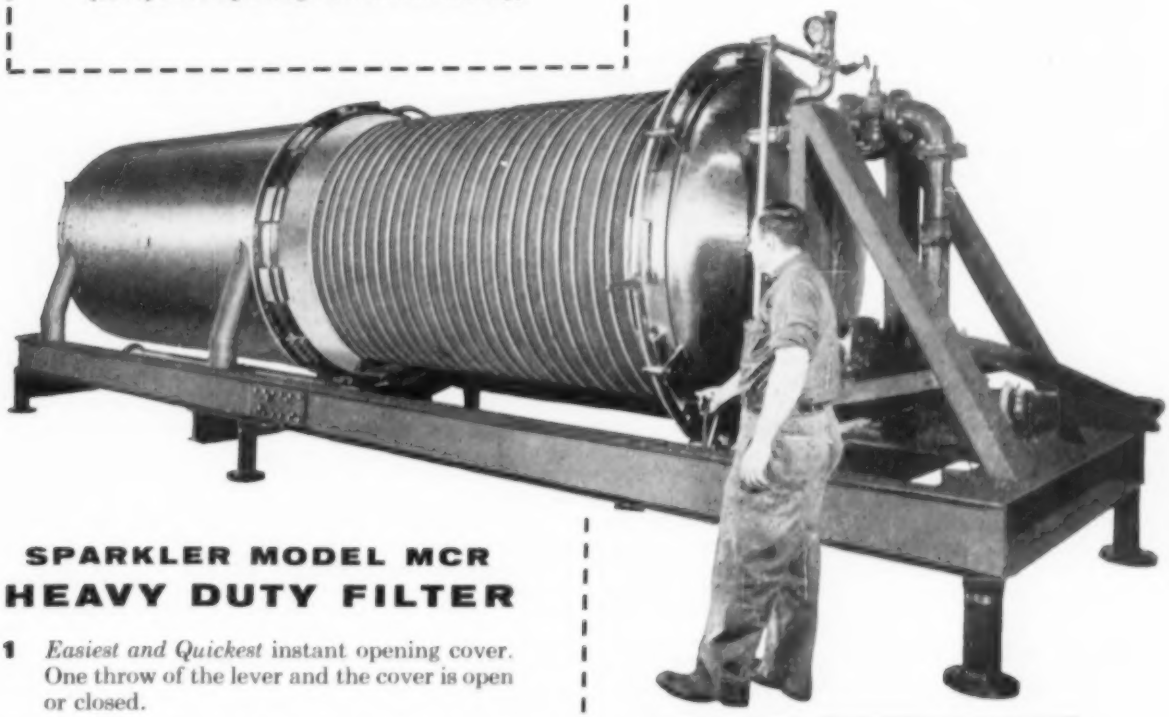
**WITH THIS FILTER**

**(as reported by a large American Brewery)**

Built to handle products with a high percentage of solids, with long operating cycles.

Engineered to lower filtration costs.
Fast cleaning with a minimum of down time.

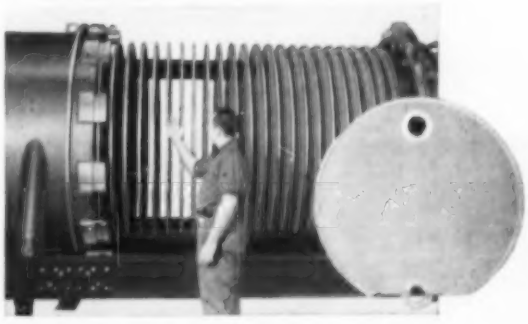
Anyone interested in reliable uniform quality, highest daily volume production, and economical operation, will not be satisfied with anything less than a Sparkler MCR.



**SPARKLER MODEL MCR**
**HEAVY DUTY FILTER**

1. *Easiest and Quickest* instant opening cover. One throw of the lever and the cover is open or closed.
2. Retractable tank, hydraulic power operated with finger tip control.
3. No breaking of pipe connections with fixed head. No spillage.
4. Plates spread far apart to allow full size cake without clogging. Large top plate outlet and bottom drainage outlet reduces flow resistance.

*Write for complete facts in bulletin*



**SPARKLER FILTERS**

**SPARKLER MANUFACTURING COMPANY**
**Mundelein, Illinois**

**Sparkler International Ltd. plants, in Canada, Holland, Italy and Australia**

*Exclusive filtration engineers for over 30 years*

# WINDY CITY HOST TO A.I.Ch.E.

**There is something symbolic in A.I.Ch.E.'s return to Chicago for this year's Annual Meeting December 8-11. This is the year that Chicago's confidence in someday becoming the major city of the Nation has at last become more than "pie-in-the-sky," and it is fitting that the chemical engineers be in Chicago to witness the start of an industrial expansion in which they will surely play a great part.**

*E. T. Harding* | Mead Johnson & Company, Evansville, Indiana

Chicago is big—second largest city in the nation—, Chicago is an industrial giant (23 plant trips are planned for the meeting), and Chicago is growing like a prairie fire (an estimated 40 additional chemical process plants alone are expected to be built in the city area in the next ten years). The rail center of the nation, Chicago is the most convenient convention city in the country.

Recreation? Chicago is a city of some 3,750,000 people and has every recreational facility. About all anyone could say is that if you want it Chicago has it—motion pictures, theaters, sports, celebrated wining and dining places, museums, opera, art galleries, some of the finest libraries, a planetarium—everything, whatever it may be.

But it is the feeling of growth, of being in the city which may become the premier city of the Nation, that will excite the chemical engineers. What will do it? Industry and the St. Lawrence Seaway.

#### Chicago—The Ocean Terminal

New York is the shipping terminal of the Atlantic—the biggest industrial-traffic ocean in the world. Montreal is second. But when the Seaway is finished by 1959, Chicago will take over the reason for Montreal's power—it will be the terminal city of the whole St. Lawrence and Great Lakes system, as close and convenient to Europe as New York, and much closer and more convenient to the "heartland" of America—that is, the industrial middle west, northwest, and even southwest.

It won't be fast, and there are many drawbacks to the St. Lawrence Seaway at the moment (one is ice four months of the year, but Sweden has done much to overcome the problem of ice-bound harbors and the St. Lawrence System may do the same), but there is little doubt that someday, and not too far away, Chicago could become the prime port of the Nation.

Already the Windy City is girding itself, is building, is planning for its new role. And the chemical industry is in the center of this activity. Nearly a score of top-priority expansion or construction jobs are just-built or building along Chicago's inland waterways system by chemical process industries.

Low cost water transportation—raw materials such as ilmenite, potash, bauxite coming in, and finished bulk products going out—is an important factor in the chemical industry. Chicago has long been a center of the vast Great Lakes and Mississippi basin water shipping system, is now rapidly working to expand its inland waterways which connect it with the Mississippi and all of America. When this is done, and the St. Lawrence Seaway is open, it will be possible for a chemical company in Iowa or Kansas to ship by water all the way to markets in Europe or farther, with only one transshipment—at Chicago.

What this will mean to Chicago is hard to visualize without coming and taking a look at the city and what is already happening. What it means for the chemical industry, for your own company in fact, should bring engineers to take a first-hand look at the potential which is going to make Chicago a major ocean port at last, if not *the* major ocean port.

#### Technical Program

And in the midst of the bustle of a booming Chicago, A.I.Ch.E. has planned a big program. On the more theoretical side, E. R. Gilliland's basic *Fluidization* session will emphasize fundamental mechanisms, while C. W. Nofsinger's *Effective Cost Control in Process Operations* will go deeply into the very practical matter of today's lower profit margins, why they are lower, what to do about it. Even more on the practical side (a *must* session for all chemical engineers) is Nofsinger's second symposium giving step-by-step evaluation of *Projects from Original Idea to Investment Stage*—including how and when to discontinue an unprofitable project.

Nuclear subjects are again much in evidence. Michigan's J. J. Martin has two sessions on the rapidly growing subject of *Radiation Processing*. There are atomic experts who think that in the not too distant future radiation processing techniques will be used in so many industrial applications that the field will surpass power reactors in technological and economic importance. Martin's symposia will empha-



The Michigan Avenue skyline and the Outer Drive. (*Courtesy N. Y. Central.*)

The lakefront at Chicago.
(Courtesy N. Y. Central.)



size the behavior of materials and equipment.

The chemical processing applications of *Heat from Nuclear Reactor Systems* of various types will be the heart of B. W. Gamson's session—this is a subject every chemical industry is going to have to watch with attention over the next few years.

*CEP* is disappointed in having to report that the final word is that W. Bebbington's *Production of Heavy Water* session will not be on the program. Federal court proceedings have continued beyond the deadline for Chicago, and the program committee has had reluctantly to withdraw the session. Bebbington's session *will* appear on some future national program as soon as the legal snarl is untangled.

Another subject covered will be metals—from beginning (*Extractive Metallurgy*) to end (*Corrosion Resistant Alloy Materials of Construction*). Extractive metallurgy, says chairman B. W. Gamson, is a field becoming more and more the domain of the chemical engineer. In this session the engineer will be able to study first-

(*Continued on page* 116)

## CHICAGO MEETING TECHNICAL PROGRAM—SCHEDULE OF SYMPOSIA

### MONDAY, DECEMBER 9

| | | | | |
|---|---|---|---|---|
| 2:00-4:30 P. M. | **Chemical Engineering Abroad,** Shelby Miller, U. of Rochester, Rochester, N. Y. | **Shock Waves in Process Equipment,** Stuart Churchill, U. of Mich., Ann Arbor, Mich. | **Cost Control In Process Operations,** C. W. Nofsinger, The C. W. Nofsinger Co., Kansas City, Mo. | **General Papers I** |

### TUESDAY, DECEMBER 10

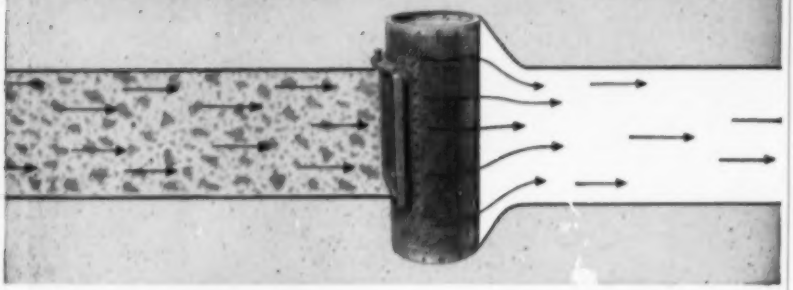
| | | | | |
|---|---|---|---|---|
| 9:00-11:00 A. M. | **Extractive Metallurgy, Part I,** B. W. Gamson, Borg-Warner Corp., Des Plaines, Ill. | **Laboratory & Pilot Plant Techniques, Part I,** G. W. Blum, Goodyear, Akron, Ohio. | **Project Evaluation from Original Idea to Investment Stage,** C. W. Nofsinger. | **General Papers II** |
| 2:00-4:30 P. M. | **Extractive Metallurgy, Part II,** B. W. Gamson. | **Laboratory & Pilot Plant Techniques, Part II,** J. M. Cummings, Fenn College, Cleveland, Ohio. | **Selling A Technical Program,** Dennis Murphy, Service Pipe Line Co., Tulsa, Okla. | **The Separation of Materials in Biological Processes,** Elmer Gaden, Columbia U., New York, N. Y. |

### WEDNESDAY, DECEMBER 11

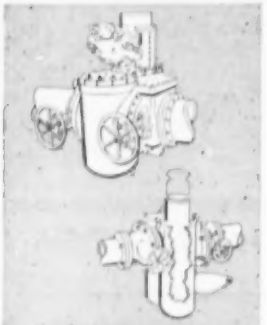
| | | | | |
|---|---|---|---|---|
| 9:00-12:00 Noon | **Nuclear Process Heat,** B. W. Gamson. | **Fluidization of Solids, Part I,** E. R. Gilliland, MIT, Cambridge, Mass. | **Corrosion Resistant Alloy Materials of Construction,** G. Fred Ours, Union Carbide Chemicals, Charleston, W. Va. | **General Papers III** |
| 2:00-4:30 P. M. | **Radiation Processing,** J. J. Martin, U. of Mich., Ann Arbor, Mich. | **Fluidization of Solids, Part II,** E. R. Gilliland. | **Application of Computers in the Practice of Chemical Engineering,** L. Cooper, Monsanto, St. Louis, and Chen-Jung Huang, U. of Houston, Houston, Tex. | **Chemical Recovery in the Pulp and Paper Industry,** R. P. Whitney, Inst. of Paper Chemistry, Appleton, Wisc. |

# ELLIOTT STRAINERS

## assure "trouble-free" clean liquids



For over 50 years, Elliott strainers have proved themselves in power and industrial plants everywhere. Removing objectionable solids that could cost thousands of dollars in lost time and damaged equipment, they keep liquids clean and free of foreign matter.

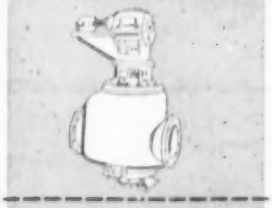


**ELLIOTT TWIN STRAINERS**
**TYPE A, for water and other liquids**

Provides continuous flow, since one strainer basket is in service while the other is removed and cleaned. Available sizes 4" to 24" for 125 psi, and 4" to 12" for 250 psi pressure. Straining-basket mesh ranges from $\frac{1}{32}$" to $\frac{3}{16}$". Also available: back-flushing strainers in manually-operated and rotary spray types, sizes 4" to 24".

**TYPE V, for lube oil, fuel oil, viscous liquids**

Uses large-size baskets to facilitate unrestricted fluid straining. Sizes from 1" to 8" for 125 psi, $1\frac{1}{2}$" to 10" for 300 or 500 psi, straining perforations from $\frac{3}{16}$" down to fine wire mesh.



**TYPE K SELF-CLEANING STRAINER**
**for removing large amounts of foreign matter in water**

Cleans itself automatically and continuously by back-flushing the straining units. Standard sizes 4" to 24", pressures 25 to 125 psi, straining units $\frac{1}{32}$" to $\frac{3}{16}$" mesh. Available with AC or DC motor, low power requirement.



**TYPE F SINGLE STRAINER**
**where flow can be interrupted for cleaning**

Excellent for liquids not containing large amounts of foreign matter, or batch processes. Quick-opening cover. Sizes 2" to 24" for pressures up to 125 psi, basket mesh $\frac{1}{32}$" to $\frac{3}{16}$".

For further details, call your nearby Elliott District Office or write Elliott Company, Accessories Department, Jeannette, Pa.

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## CHICAGO MEETING

(*Continued from page* 115)

hand some new and novel systems of extraction. Corrosion needs no introduction to chemical engineers. G. Fred Ours, the symposium chairman, says simply that his session will give new information, unlock some new doors for corrosion control in process equipment. That is all a chemical engineer should have to hear to come running.

Shelby Miller's *Chemical Engineering Abroad* session is going to be an insider's report by travelled members of the Institute on the what and where of chemical engineering progress in Russia, France, Great Britain, Italy, and Germany. Educational aspects will be covered as well as the industrial side.

Back home, a new approach to pilot plant operations will be revealed in the *Laboratory and Pilot Plant Techniques* sessions. G. W. Blum's morning meeting will cover primarily the economics of planning pilot plant programs, and J. M. Cummings' afternoon gathering will cover the problems encountered in specific case histories or in new types of equipment.

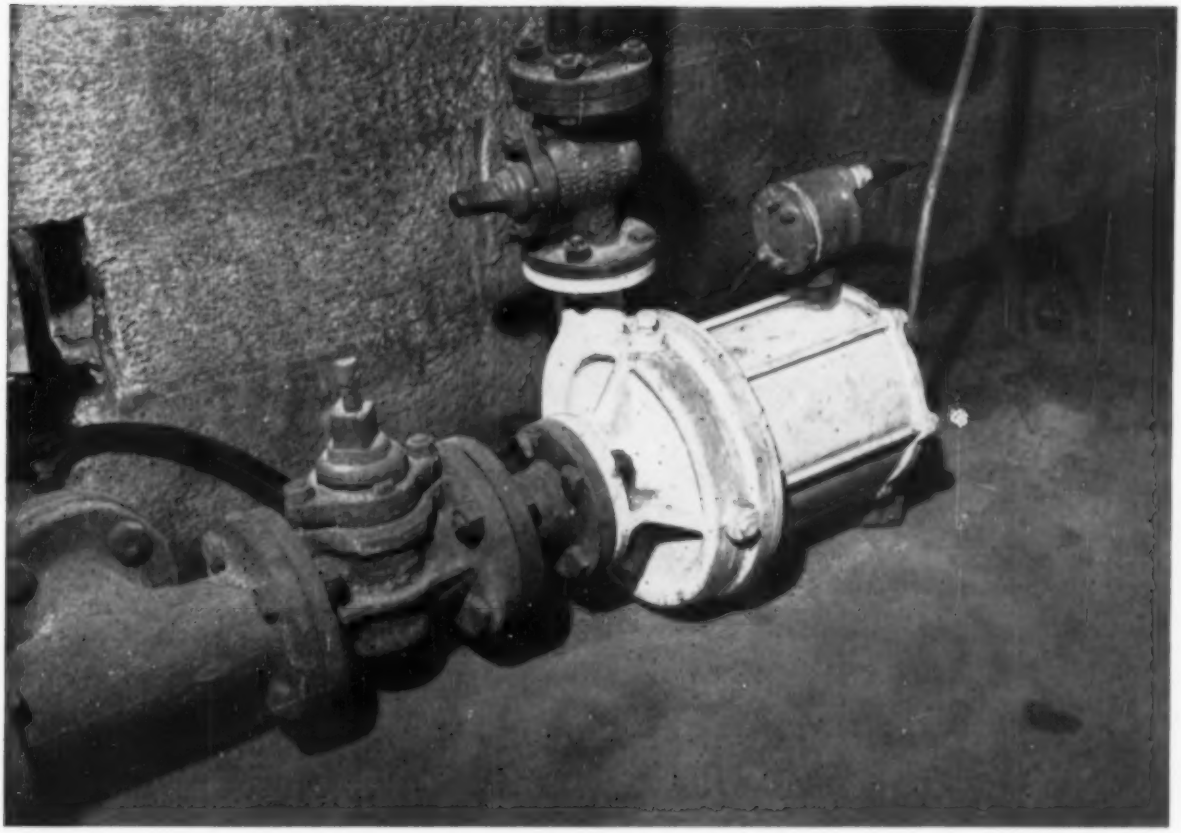
Practical and theoretical—that is the word on Stuart Churchill's *Shock Waves in Process Equipment* symposium. The papers will "discuss conditions for the formation of detonations, shock waves, potential impact pressures, behavior of equipment and materials under impulsive loading, criteria for design and operation, and a case history of the detonative failure of a large refinery processing unit."

The finest bridge in the world is of no use unless you build a good road to it. Exactly how to go about selling a technical program to management will be the meat of D. Murphy's *Selling A Technical Program* session. One tip: horizontal and vertical communications within the company are of equal importance, both must be developed.

"Not what may be done in the future to apply computers to the chemical process industries, but what is already being done *now* with computers in chemical engineering"—that is the note sounded by Leon Cooper and co-chairman Chen-Jung Huang concerning their *Impact of Computers* symposium. Results of work on problems such as multi-component, multi-column distillation and refinery economics will be featured.

A rare peek inside the operations of the pharmaceutical industry will be given chemical engineers by Elmer

(*Continued on page* 118)



# Chempump solves leakage problem

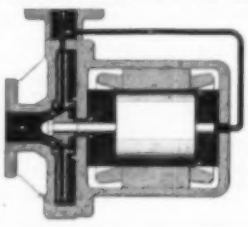
## handling carbon tetrachloride at chlorinated products plant

Carbon tetrachloride is tough to handle. It's "slippery", and has a way of oozing through even the best seals and packing. At this major chemical company's chlorinated products plant, conventional centrifugals were used to pump carbon tetrachloride from storage tanks to drums and tank cars. Stuffing box leakage was a persistent problem. Maintenance and downtime costs ran high.

Like many other chemical processors, this company uses *Chempump* to tame hard-to-handle fluids. Since replacement of the conventional centrifugals with two *Chempumps*, leakage has ceased to be a problem. The only maintenance required on the pumps, now well into their second year of service, has been a precautionary change of bearings. External lubrication is eliminated—bearings are constantly lubricated by the pumped fluid itself.

There's a good chance that *Chempump's* many unique advantages can be profitably applied in your own processing operations. For details, write to Chempump Corporation, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives in over 30 principal cities in the United States and Canada.

**No seals, no stuffing box, no leakage**



*Chempump* combines pump and motor in a single leakproof unit. No shaft sealing device required.

U.L. approved. Available in a wide choice of materials and head-capacity ranges for handling fluids at temperatures to 1000 F. and pressures to 5000 psi.

Chempump

**First in the field...process proved**



A 6000#/24 hr. capacity W&T chlorinator is used on the central cooling water system at Marcus Hook, Penna. refinery of Sinclair Refining Company.

**W & T CHLORINATION . . .**

*the economical way to prevent slime in cooling waters*

Water used for cooling operations at the Marcus Hook refinery of Sinclair Refining Company is chlorinated to prevent slimes from fouling plant units and lowering cooling efficiency.

Chlorination of the system is accomplished by one W&T chlorinator operated from a program control panel. The control automatically starts and stops chlorination in accordance with a preselected schedule. Slime growths are eliminated in the cooling units without the need for continuous treatment.

For information about W&T chlorination for slime elimination write for Bulletin CD-43.

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## CHICAGO MEETING

(*Continued from page 116*)

Gaden's *Separation of Materials in Biological Processes* session. Special operations little known outside the industry will be revealed, and an added feature will be details on the recovery of antibiotics on a commercial scale. Recovery is the key of R. P. Whitney's symposium also—*Recovery of By-products from Paper Operations*, a chemical industry that will be big in the perhaps very near future.

### Chicago Is The Annual Meeting

Don't forget that Chicago will be the Annual Meeting. That means you'll meet your new officers, attend the Annual Banquet to see them installed. It also means Committee meetings—all the Committees will meet and report. If you want to get together with the Committees closest to you, just look them up, get in touch with the chairmen, and sit in.

An Annual Meeting also means the Student Award winners, the Institute Lecture (it will be U. of Cal's C. R. Wilke this year, his subject—*Fundamental Progress in Mass Transfer*—details later), the presentation of the William H. Walker Award, the Professional Progress Award, and the Junior Member Award.

### Plant Trips and Ladies Program

Full schedule of Plant Trips will follow next month, but here is just a taste of the planned 23: Argonne National Lab, Standard Oil's Whiting refinery, Abbot Labs, Corn Products Refining, U. S. Steel, The Chicago Tribune.

For the ladies, Chicago is, of course, a major shopping center. (No more on that—we might frighten your engineer too much.) "Doing-the-town" as a group or on your own will be planned for you. Late breakfasts, special luncheons, and all the recreational advantages of Chicago will be at your disposal.

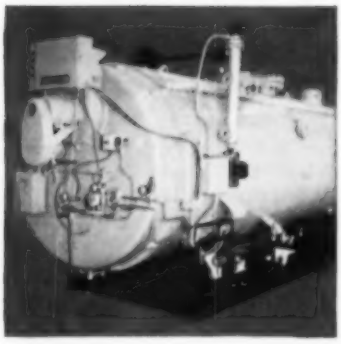
### Gentlemen, Join The Ladies

Just a few more details on what Chicago has to offer if there is any time left from the technical program. Come early on Sunday and see the Bears-Cardinals professional football game. Take in the World Bowling Championships and carry home some pointers for your team. And don't forget the "Nine Wonders of Chicago"—Adler Planetarium, the Art Institute, Brookfield Zoo, Buckingham Fountain, Chicago Historical Society, Chicago Museum of Natural History

(*Continued on page 120*)



# Flintkote applies asphalt at 485°F.



A horizontal vaporizer (above) is used by Flintkote. Low pressure performance (144 p.s.i. at 750°F.) of Dowtherm permits the use of compact, thin-walled equipment.

## Dowtherm (Dow heat transfer medium) makes precise process temperature (±1°F.) possible with no coking or carbonization

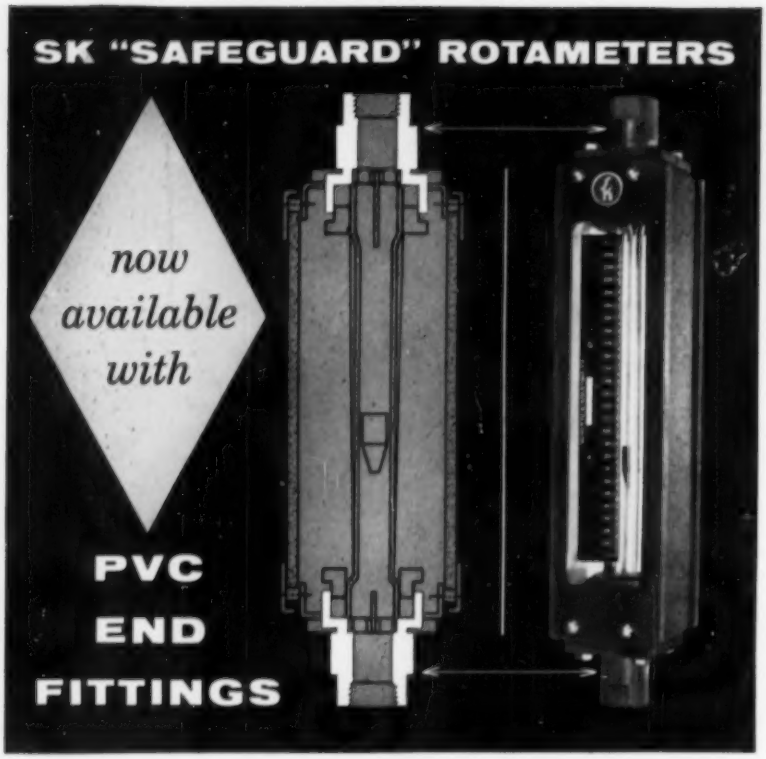
Applying asphalt at 485°F. is a hot job. And when the temperature can't vary more than a few degrees F., *it's a hot problem!* And that was the problem facing The Flintkote Company in Chicago Heights, Illinois.

To obtain the required temperature control, Flintkote decided to invest in an entirely closed heating system using Dowtherm® as a vapor heating medium.

With Dowtherm they found they could use more compact and thinner-walled equipment. Fraction-of-a-degree temperature accuracy was easily maintained. With the heating source far from the processing area, they practically eliminated any problem of burning asphalt. Dowtherm also completely did away with "hotspots"—providing more uniform heating and at the same time cutting down on equipment cleaning time.

*Manufacturers of closed heating systems using Dowtherm will gladly study your heating process. They will design equipment to fit your needs. For more information about this interesting, useful and economical product, call us. We'd be delighted to meet you.* THE DOW CHEMICAL COMPANY, Midland, Michigan, Dept. BD 846 J-1.

YOU CAN DEPEND ON DOW




*New Bulletin 18RG describes SK's line of "Safeguard" Rotameters and gives detailed instructions for liquid and gas sizing. A special sheet lists fluids for which PVC is recommended. Send for your copy.*



SK "Safeguard" Rotameters with Polyvinyl Chloride (PVC) end fittings are now available for measuring the flow of hydrochloric acid, sulphuric acid, and the many other chemicals for which PVC is recommended. As a matter of fact, these new Rotameters are already being used for corrosive fluid service with excellent results.

Two facts regarding this new PVC "Safeguard" Rotameter are of particular importance.

First, this instrument provides a Rotameter with chemical resistant end fittings and rotor at much less cost than a similar instrument with these components made of other special corrosion resistant materials.

Second, the Fig. 18275 "PVC" Rotameter incorporates all of the features of the SK "Safeguard" line—one piece fabricated steel case, tube and rotor versatility, heavy safety glass windows, adaptability to panel mounting and to electric or pneumatic transmission for remote recording and controlling of fluid flow, and others.

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## OVERSEAS NEWS

**Standardization on a world-wide basis in the nuclear energy field** is under way under the auspices of the International Organization for Standardization (ISO). First steps were taken by 61 delegates from 13 countries in a recent meeting in Geneva, Switzerland. Projected areas of work include: development of a tri-lingual glossary of nuclear terms; adoption of an international system of units; and engineering symbols; international recommendations on radiation measurement and protection; and development of acceptable international guides for safe design, operation, and maintenance of nuclear reactors. □

**A 14,000 metric ton a year styrene monomer plant will be constructed in Ravenna for the Italian company ANIC** by the engineering division of Societe Belge de l'Azote et des Produits Chimiques du Marly, Liege, Belgium. Plans, process information and know-how will be supplied by Koppers Co. □

**Electrolyzers for the $60,000,000 Nangal fertilizer and heavy water project in India will be supplied by Oronzio de Nora of Milan, Italy.** About 6,500 cells grouped in sixty electrolyzers of the filter press type, each rated at 10,000 amps., will be installed, hydrogen capacity will be more than 25,000 cubic meters per hour. The Nangal project is designed to harness the waters of the Sutlej river and thus to develop the agricultural and industrial resources of the Northern Punjab. □

## CHICAGO MEETING

(*Continued from page* 118)

(Field Museum), the Museum of Science and Industry, Shedd Aquarium, and the great Union Stock Yards.

There are twenty colleges and two hundred technical schools in Chicago. More than New York, London, or Paris. Visit Northwestern, U. of Chicago, Illinois Tech, and the U. of Illinois.

Tired and hungry? Every kind of restaurant imaginable awaits you from Barney's (yes sir, Senator!) Steak House to Sweden on the near north side and Cantonese treats at Don the Beachcomber's. For just plain American meat—The Stockyards Inn. It doesn't matter what kind of food you want, Chicago has it.

*Why* **DYNALOG*** *design is out front of all electronic potentiometers . . .*






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Just stand near an operating Dynalog Electronic Instrument, and you'll quickly learn one reason why it gives longer sustained accuracy and maintenance-freedom than other balancing-type process control instruments!

There's none of the usual buzzing and clicking, because Dynalogs have no slidewire or fast-moving parts. Instead, a simple, variable radio-type capacitor with silent magnetic drive gives *stepless* continuous balancing — smoother, faster response — without noise, waste motion or wear.

In addition, this unique Dynalog Design is inherently free from "drift" . . . has no dry cells to standardize or replace . . . requires no lubrication or realignment . . . insures years of trouble-free performance without continual "policing". Dynalog Recorders and Controllers are used with any primary element . . . resistance, voltage, capacity, inductive. For the complete story, write for Bulletin 20-10. **The Foxboro Company, 819 Neponset Avenue, Foxboro, Massachusetts, U.S.A.**

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*Advance features to improve control of temperature, pressure, flow . . .*

1. No periodic maintenance
2. No dry cell—no standardizing
3. No high-speed moving parts
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5. *Stepless*, continuous balancing
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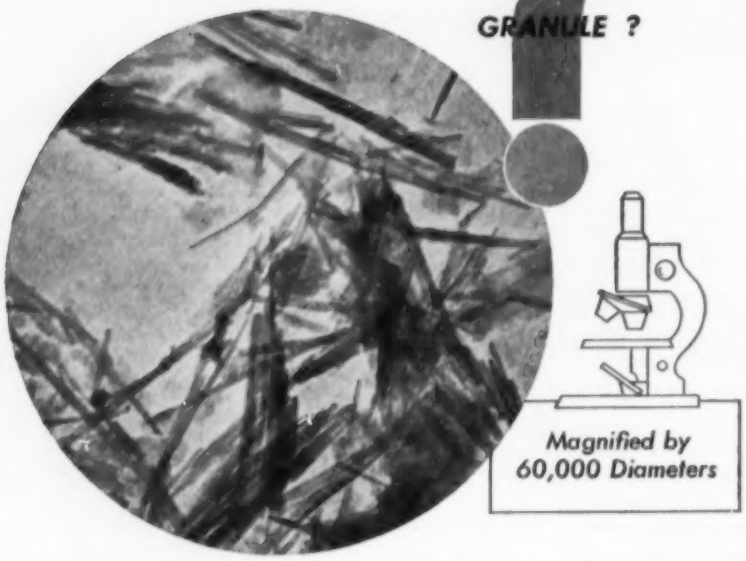
5 DIFFERENT MODELS employing Continuous Oscillating or Gravimetric Methods. For obtaining ACCURATE samples, use The FICKLEN Method. Tell us your dust problems.

**Joseph B. Ficklen, III,** 1848 East Mountain Street, Pasadena 7, California
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EVER LOOK INSIDE A

# Florex?

GRANULE ?



Magnified by 60,000 Diameters

The fibrous nature of Florida Fullers Earth, commercially available as Florex, reveals each unit consisting of about 2200 molecules in a bundle, providing ready selectivity in adsorption of color and contamination from organic and inorganic liquids and gases.

Florex quality means specially processed fullers earth giving maximum surface area and adsorption efficiency. Florex is unequalled in high quality or low cost for processes involving the use of highly active clay for sweetening light distillates, dehydration, desulfurization, and polymerization.

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## RESEARCH NEWS



An airborne laboratory, contained in a Sikorsky S-55 helicopter, is used by Aero Service Corp., Philadelphia, to search out deposits of ore and oils. Findings of three separate detecting instruments are recorded on a Brush direct-writing oscillograph. A magnetometer seeks out ores such as iron, ilmenite, and nickel as well as potential oil-bearing areas. An electromagnetic detector finds electrically-conducting sulfides of lead, zinc, and copper, while a scintillation counter responds to uranium, thorium, and other radioactive elements.

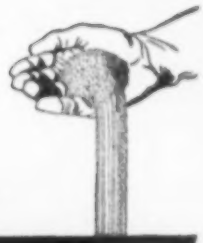
**Temperatures as high as 6,300° F.** for testing purposes are attained at the B. F. Goodrich Research Center in Brecksville, Ohio, by concentrating the sun's rays with a surplus Army searchlight. Result is high temperature with no danger of sample contamination from furnace elements or containers. □

**A plastics research laboratory, cost $750,000,** has been completed by General American Transportation at its East Chicago, Ind., plant. An elaborate research schedule will cover moldability, strength, chemical resistance of reinforced plastics, and vacuum forming and injection molding of thermoplastic materials. □

**An expanded research program at Sun Oil Co. will be highlighted by the October dedication of their new $2,500,000 research laboratory** in Marcus Hook, Pa. The new building is adjacent to Sun's Marcus Hook refinery, will also permit close cooperation between the research group and the company's technical economics and commercial development groups in Philadelphia. □

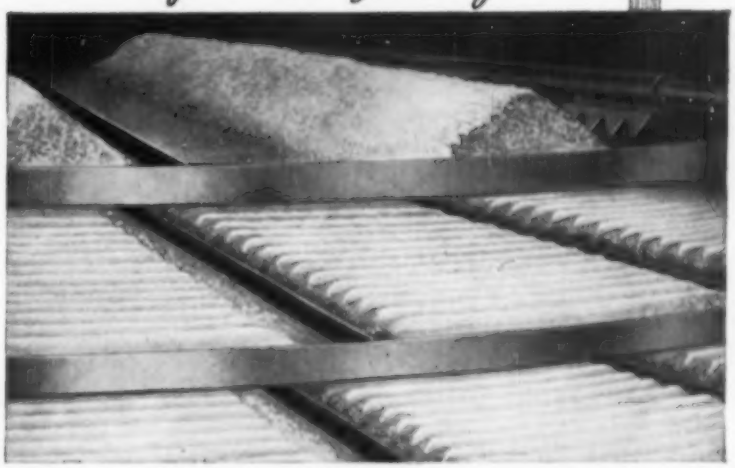
**Gibberellic acid research will be accelerated** by more than 30 new grants-in-aid established by Merck & Co. The work, to be carried out at leading agricultural research centers, will concentrate on the properties of the compound which, in recent experiments, has been shown to be capable of doubling and tripling the growth of several kinds of plants. □

# HOW TO BE GENTLE



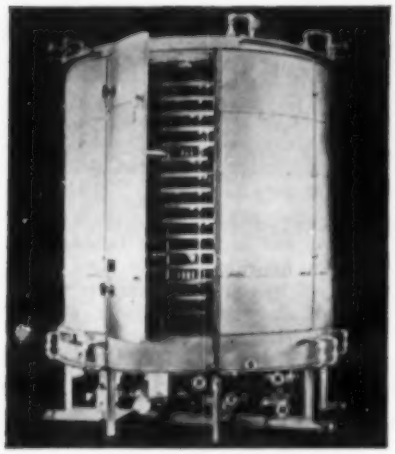
*..... with the product you dry*

**If you have a product which must be dried uniformly with minimum degradation of particles and without overheating . . . then you will be interested in learning about the Wyssmont approach.**



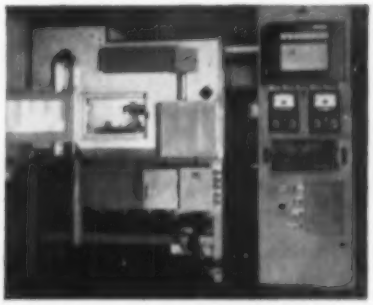
**UNIFORMITY AND NON-OVERHEATING** are accomplished by mixing and exposing new surfaces to the drying medium. The Wyssmont TURBO-DRYER® achieves this *without degradation* by intermittent and gentle piling and spreading of the product.

**SLOWLY, GENTLY,** fixed wipers slide the product off one tray to another only a few inches below, where fixed levelers spread it into serrated rows. This is repeated once on each tray shelf. Thus ALL the product is moved positively through exactly the same drying conditions in exactly the same time. ***No other drying system provides this combination of Blending with Equal Environment and Positive Displacement!***





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**FOR A LOAN** of a sound-and-color film, or for literature about the TURBO-DRYER®, write today to: Wyssmont Company, Inc., 42-03B 27th St. (Bridge Plaza South), Long Island City 1, N. Y. Representatives in principal cities.

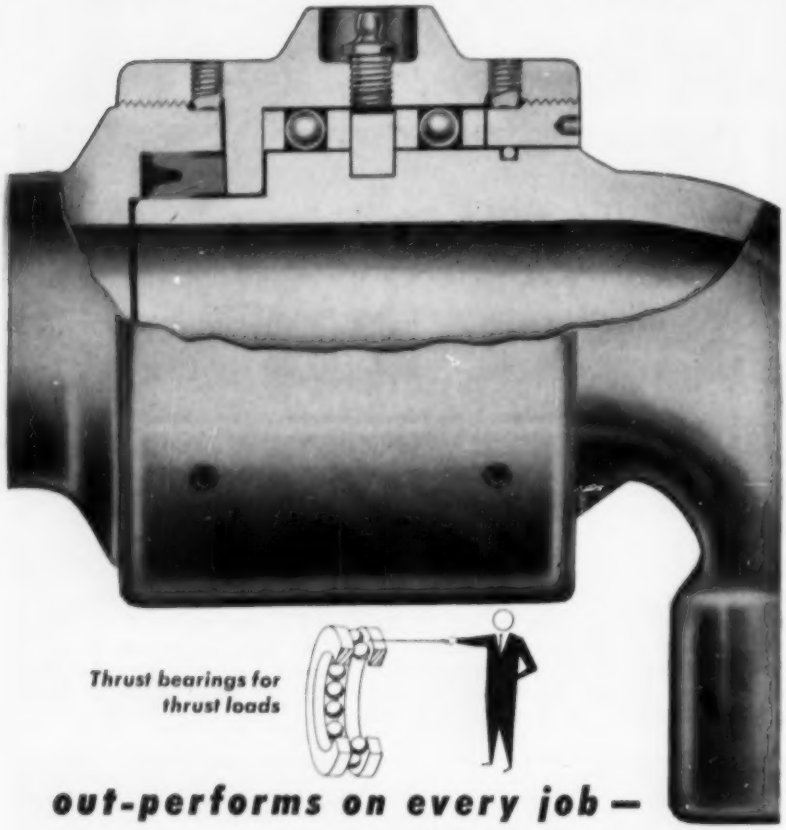
TURBO DRYER

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DRYING & PROCESS ENGINEERS

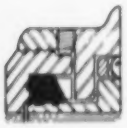
The Wyssmont TURBO-DRYER® is applicable to continuous drying with SOLVENT RECOVERY, continuous purification by SUBLIMATION, continuous SOLID-GAS REACTIONS, and as a DRYER-COOLER.

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## RESEARCH NEWS



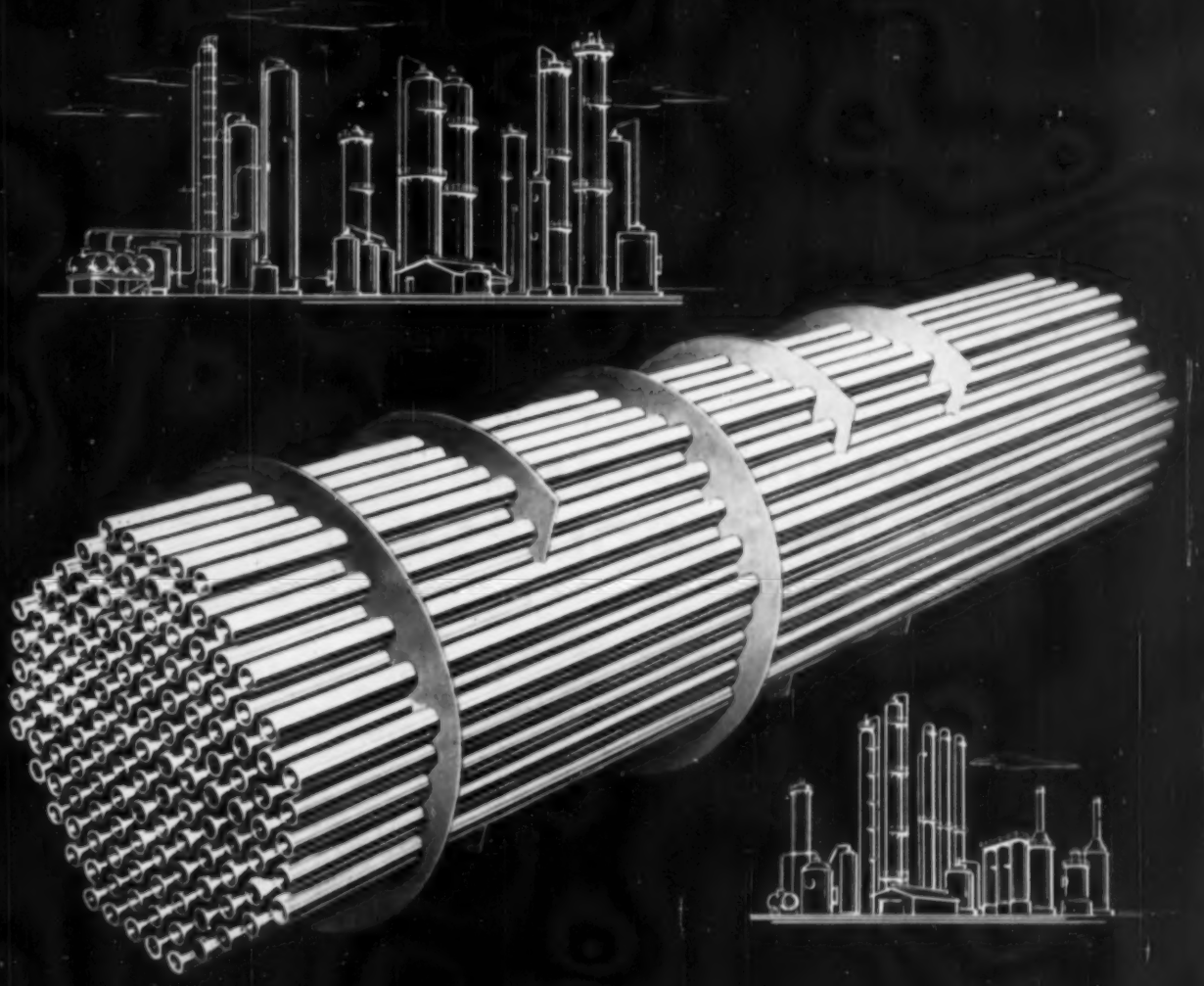
Physical properties of solid particles ranging in size from 12 inches to less than one micron will be studied in a new Niagara Falls, N. Y., laboratory of Electro Metallurgical Co. Crushing and grinding equipment will be supplemented by several types of furnaces and auxiliary equipment for agglomeration studies, and a pilot-scale fluidized bed reactor.

**A series of lectures on the chemical effects of radiation** will be given by a group of prominent chemists from government research laboratories, industry, and universities at Northwestern Univ. beginning October 1. The lectures will be non-credit courses given on Tuesday evenings at the Technological Institute. Opening the series will be Prof. Milton Burton of Notre Dame with an introductory lecture. Malcolm Dole of Northwestern is chairman of the courses, will be the final speaker. His subject—"Kinetics of Radiation Effects in Polyethylene." Other lecturers will come from Oak Ridge, Brookhaven, Argonne, Purdue, Mellon Institute, Dow Chemical, and General Electric. Registration can be made at the first lecture. □

**Square and rectangular bubbles in lithium fluoride crystals** have been produced by neutron irradiation at the GE-operated Knolls Atomic Power Laboratory. The discovery may lead to important findings in the field of atomic structure. □

**The role of lithium and its compounds in polymerization reactions will be studied** in a research program at Princeton University. The program, sponsored by the American Lithium Institute, will be aimed at the use of lithium and its compounds as initiators and modifiers in vinyl polymerization and copolymerization. □

**Chemical metallurgy research facilities will be more than doubled** by a large addition to the Process Research Building at the Metals Research Laboratories of Electro Metallurgical Co. in Niagara Falls, N. Y. □



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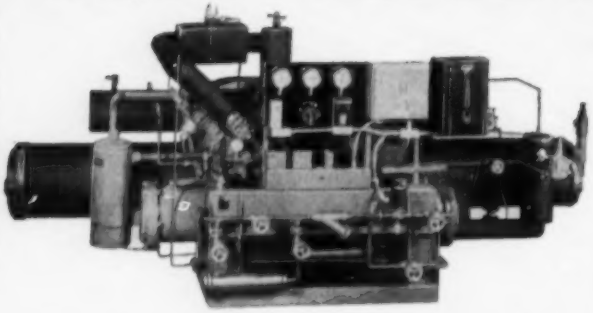
*Faced with a Cooling Problem?*



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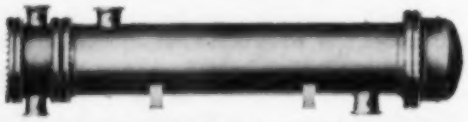
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## NUCLEAR NEWS



Operation has been resumed at the North Carolina State College nuclear reactor following installation of a new core. The unit, a water-boiler type fueled with uranyl sulfate in solution, has been functioning since 1953. In pic, Atomics International engineers check new core.

**A reduction in the price of cobalt 60 sources sold commercially for research, development, or industrial applications** has just been announced by Nuclear Systems, a division of The Budd Co. Ranging from 50 to 75 per cent, these reductions apply to all sources ranging up to 50,000 curies. □

**A contract for the detailed design of a boiling reactor facility** to be erected at Argonne Laboratory's Idaho Division site has been awarded to United Engineers & Constructors, Inc., Philadelphia, Pa., by the Laboratory. Anticipated cost of the Argonne Boiling Reactor (ARBOR), as now planned, will be about $8,500,000. Completion of design work is scheduled for May 1, 1958, contracts for the erection of the facility will be awarded by about July 1, 1958. □

**A "pebble-type" reactor, said to be capable of generating steam at 1,450 lb./sq.in. at 1,000° F.,** is under design by Alco Products, Inc., in cooperation with Sanderson and Porter, engineers in New York. If successful, the system could take advantage of the efficiency of modern high-pressure steam turbines and electrical generators. Heart of the proposed reactor is a collection of parallel tubes filled with small uranium-containing spheres, heat transfer medium will be helium gas. □

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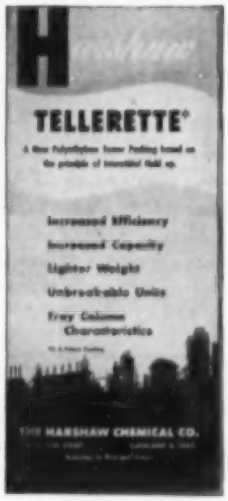
**Increased Capacity**

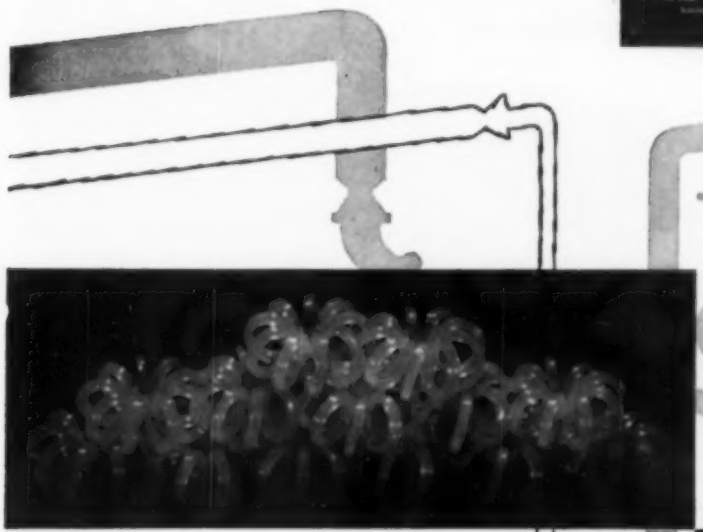
**Lighter Weight**

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**Tray Column Characteristics**

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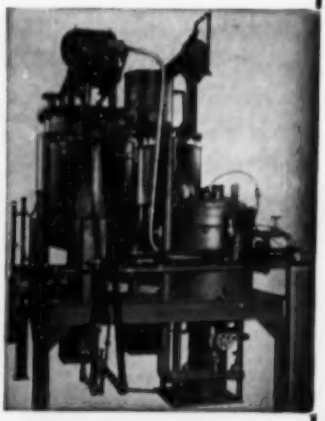
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## EUROPEAN EXPERTS TOUR U.S. NUCLEAR DEVELOPMENT FACILITIES

50 key participants in Euratom—technicians, industrialists, and government officials—have just completed a tour of A.E.C. facilities and privately-owned nuclear installations in the United States. Representing Belgium, France, West Germany, Italy, Luxembourg, and the Netherlands, the visitors' main interest lay in determining which types of reactors could be built in Europe at an early date. Their investigations were not limited to reactors but included fuel element fabrication, pressure vessel fabrication, chemical processing techniques.

---

**The first atomic energy reactor in the Far East began operation August 27** at the new nuclear research center about 70 miles from Tokyo. The reactor, designed and built by Atomics International, is fueled with uranium in water solution, has a power level of 50 kilowatts. Operated by the Japan Atomic Energy Research Institute, it will be used for the production of radioisotopes and for varied research, including medical and agricultural studies. □

**Nuclear core component and core assembly manufacturing facilities** are being expanded by Westinghouse at their Cheswick, Pa., plant. Expansion is second phase of company's multi-million dollar, two-year project begun in late 1955 to keep pace with Navy's nuclear ship program. □

**Italy will have a 50-kilowatt research reactor** to be supplied by Atomics International, division of North American Aviation. The "solution-type" reactor, fueled with enriched uranyl sulfate in water solution, will be located in Milan, will be used for research and training. By-product radioisotopes are earmarked for use in industry and agriculture. □

**World's first industry-owned nuclear materials testing reactor** is under construction by Westinghouse at a site near Pittsburgh. Power will be in the range of 20,000 kilowatts, testing facilities will accommodate large size fuel elements. The unit will employ highly-enriched uranium as fuel, moderator and coolant will be water. □

**Final shipment of a large order of radiation protection devices** has been made by Tracerlab to the French Atomic Energy Commission. □


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**EASY TO REGENERATE 4-BED CABINET TYPE** Barnstead model FR-2 produces extremely pure demineralized water at flow rates of from 30 to 100 gallons per hour. Stainless steel cabinet. Standard equipment includes filter, purity meter, flow rate indicator, pressure gage, valves, regenerant tanks.

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☐ Bulletin 141–MF Submicron Filter

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## NUCLEAR NEWS

**Courses in nuclear engineering are in the works at Carnegie Tech.** The courses will lead to a master's degree in nuclear engineering for students who have done undergraduate work in the fields of chemical, mechanical, or metallurgical engineering; physics, mathematics, or chemistry. Nuclear engineering will be a cross-department program. It will use new courses pinpointing nuclear topics (about 25 per cent), and a broad sweep of established courses in the above fields (about 75 per cent). ☐

**Nuclear reactor cores will be assembled** at a small plant to be erected by Olin Mathieson near Montville, Conn. Completion date for the facilities is spring of 1958. Provision is being made for further expansion, but, for the present, components for the reactor cores will continue to be made in the company's New Haven plant. ☐

**General Electric plans to export a 3000 kilowatt (thermal) pool type reactor to Spain.** The unit will use uranium enriched to 20% U-235 as fuel. The reactor will be shipped to the Junta de Energia Nuclear and be located in Madrid. ☐

**An experimental fuel element contract has been signed between the Nuclear Division of The Martin Co. and Phillips Petroleum Co.,** operator of the Material Test Reactor, Arco, Idaho. The contract calls for Martin to supply to Phillips four tubular fuel element assemblies, with each assembly comprised of numerous aluminum, tubular elements enclosed in an envelope for installation in the MTR.

Two of the tubular element assemblies will each contain 1,000 grams of natural uranium dioxide, and the other two will each contain 1,000 grams of uranium dioxide enriched with 20 per cent U-235. All of the elements will be inserted into the active core of the Materials Test Reactor. Main purpose: to test how well the 20 per cent enriched elements operate. ☐

**A Van de Graff accelerator has been installed, and research work has begun, at Union Carbide's laboratory in Sterling Forest, N. Y.** At present, research work is going ahead in temporary quarters pending the completion of Carbide's new facilities which are now in construction. Heart of the completed laboratory will be a 5 megawatt pool-type research reactor, designed and built by the Atomics Division of American Machine & Foundry Co. ☐


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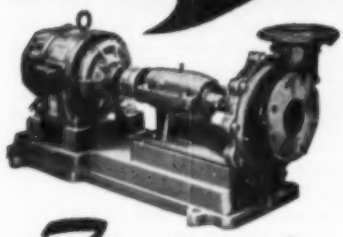
These low-loss storage and transport units are skid, caster, wheel and trailer mounted and are available in capacities to 3500 gallons. Larger vessels for bulk liquid storage are sized to 10,000 gallon capacities. All units feature standard equipment as follows: bottom fill and discharge line, top fill line, liquid level gauge, vacuum valve and filter, thermocouple vacuum gauge, pressure gauge, A.S.M.E. code stamped inner vessels, quick pressure build-up system, extended stem valves on liquid lines, ending with Hofman quick couplings.

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- **Pump sizes from 1" to 4" discharge openings.**
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- **Heads from 30 up to 220 feet.**
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**CONSTRUCTION ADVANTAGES**

Pump casings are vertically split for easy accessibility. Mounted on a swivel to permit placing discharge in any desirable position. Pump openings, both suction and discharge, flanged to permit easier connection and disconnecting to joints. One-piece impellers, securely attached to shaft by stout key and lock nut, or threaded, give long service. Pump bearings mounted in sturdy frame horizontally split for easier accessibility. Extra long stuffing box provides for oversize stuffing. Mechanical seal also available for minimum leakage. Pump coupling flexible for direct connection to drivers or can be arranged for belt drive. Pump speed, pump openings, etc. are selected to suit your particular requirements.

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## INSTITUTIONAL NEWS

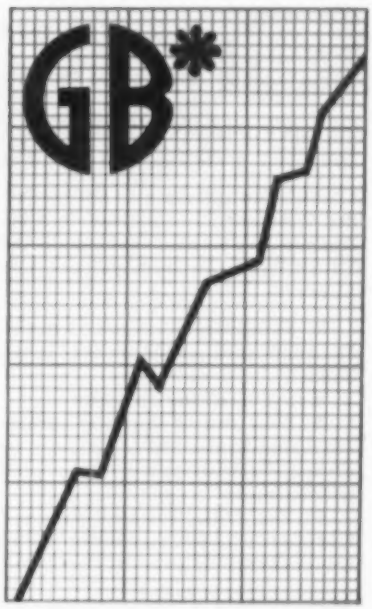
**The course on Commercial Chemical Development, given at Columbia University** last year by John O'Connell of Amoco Chemicals, will be repeated this year under Carlton A. Sears, director of product application, Farm and Home Division, American Cyanamid Co. Offered will be a survey on developing and marketing of new chemicals. Guest speakers from industry will present actual case histories. Information from W. H. Trotter, R.D. No. 1, Box 244, Bound Brook, N. J. □

**A "practical engineering approach to the particulate emission problem"** will be stressed at the second annual Air Pollution Symposium of the Franklin Institute, Philadelphia, October 21, 1957. □

**An Honors College which will provide a special educational program for students of superior ability** and achievement has been established at Michigan State Univ. At the end of the freshman year, all students who finish their first year with a B-plus average will get the option of entering the Honors College. Once assigned, all requirements for graduation, other than total hours, will be waived. Individuals will work out with an advisor programs of study suited to their capacities. □

**A full report on the questions and answers elicited by the 82 technical and management papers presented at the 12th Annual Conference of the Reinforced Plastics Division** of the Society of the Plastics Industry, Inc., have been compiled in a Proceedings volume. With the talks themselves in a 562-page preprint book, both volumes are available at $7.00 plus postage. □

**One of the largest freshman engineering classes (second only to the returned-G.I. year of 1946) enrolled in engineering colleges last year.** There is no evidence that qualified students are being turned away from engineering colleges and currently there is no shortage of engineering students. Although there are serious problems, such as faculty availability and student selection, engineering educational facilities have, in general, comfortably assimilated this high enrollment. These conclusions are a result of a survey recently completed by the Engineering Manpower Commission of Engineers Joint Council. □




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## PLANT MAINTENANCE, CONSTRUCTION, AND SAFETY FEATURED AT SOUTH TEXAS

**Chemical engineers at Galveston on October 18 for the Twelfth Annual Technical Meeting of the South Texas Section will see and hear:**

- **Symposium on plant maintenance and construction practices**
- **Symposium on safety**
- **Two major general paper sessions—featuring a paper on Phase Equilibria by D. L. Katz of Michigan**
- **The new Moody Convention Center which accommodates an audience of several thousand.**

This year the South Texas Section has gone all-out to capture both local and national speakers for its 16-paper program on Friday, October 18.

For engineers interested in petroleum production research, natural gas production, and anyone concerned with mass transfer problems, Jack Cinque, American Oil Co., will preside over the first general paper session, will cover all these subjects. Bonus: J. Eckert, chief engineer of U. S. Stoneware Co., will describe and analyze the Pall ring, a new type of tower packing.

Another morning session, under the direction of Du Pont's C. J. Kramis, will cover Maintenance and Construction, will serve to help in planning and executing a systematic maintenance program. A look into the future is scheduled to give a rundown of basic needs to be met in the highly mechanized plants of tomorrow. Another feature—how chemical engineers can lower construction costs when given the opportunity to carry or share the responsibility of the complete plant design.

New Moody Convention Center will be site of South Texas Annual Technical Meeting.



#### Phase Equilibria—Radiation Hazards

Today, the chemical engineer confronted with handling fluids at high pressure finds it necessary to restudy all earlier work and fill in data on the substances he is handling. Better methods of predicting phase behavior are needed, and various routes to this end will be considered by Michigan's D. L. Katz in his important paper on Phase Behavior at High Pressure. The paper is part of C. L. Umholz's afternoon general session, but is considered so important that the simultaneous session on Safety will be adjourned in time for everyone present to hear Katz.

The importance of natural gas in the chemical industry, including some crystal-balling on the future, will also be emphasized in Umholz's session.

Other highlights will give the chemical engineer ideas on the use of electronic aids with broad applications in chemical engineering, and detailed information on Dow's program to evaluate atmospheric corrosion rates at its Freeport, Tex., plant.

Radiation hazards and how to plan for disasters will be the meat of the afternoon session on Safety. Presiding officer R. D. Hornbeck of Alcoa promises some new details from engineers with experience in this relatively new but vital field.

(*Continued on page* 134)

## CHEMICAL ENGINEERS COME TO NEW YORK—COST ESTIMATION, CONTROL ENGINEERING, AND PROFESSIONALISM

**The All-Day Symposium of the New York Section, A.I.Ch.E., October 22, 1957, again features Cost Estimation, will add Control Engineering, legal pitfalls involved in "engineering knowledge," and the problems of professional licenses.**

Cost estimation has long been the most provocative feature of the annual New York Section All-Day Symposium. To be held at the Hotel Statler October 22, this year's meeting will also feature a symposium on Control Engineering—A Challenge to Chemical Engineers; the legal problems involved in trade secrets, the employer-engineer relationship relating to knowledge the engineer may develop, patents, and more of the legal problems an engineer can run into when doing his work for a corporate employer; plus a session on the pros and cons of licensed engineers.

#### Control Engineering—Legal Snarls

Kicking off at 9:30, L. E. Slater's Control Engineering symposium will get right down to work describing why and how control systems engineering offers a powerful new tool to the chemical engineer. A main function: improving present processes and helping to synthesize new processes. There will be plenty of practical application details, and a long look into the future designed to help the chemical engineer visualize the effects of the new operations on his processes and on himself.

Simultaneously, B. Greffrath, Food Machinery & Chemical, will lead his symposium through the pitfalls of legal relations mainly concerned with the chemical engineer's most important asset—knowledge. As far as patents go, just what is the situation between engineer and employer? Who owns what? Also, the whole matter of contracts between engineer and employer will be studied. Trade secrets are often a trouble spot, particularly when an engineer leaves one company and goes to another.

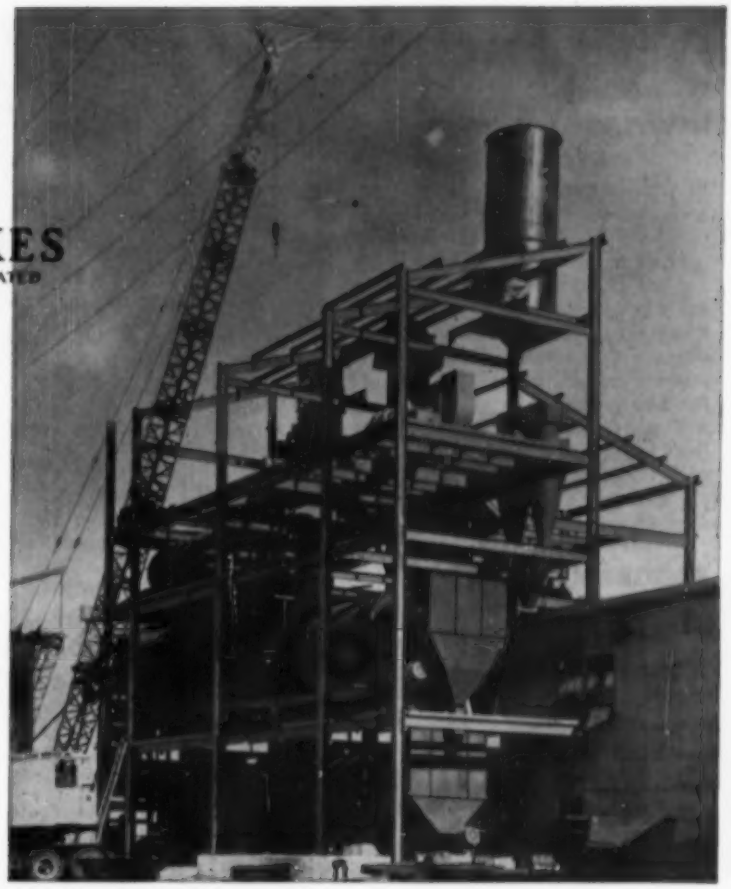
#### Cost Estimation—Licensed Engineers

This year's Cost Estimation session concerns Planning for Profits: E. E. Winne, a v.p. of W. R. Grace's Polymer Chemicals Division, will preside. Always useful, this session will be more so this year, beginning with a single, simple, accurate, and dependable guide with which to make straightforward, impartial comparisons of rates of return on investments and therefore measure profitability. The steps to be taken when determining the profitability of new products will be reported on and illustrated from the practical experience of W.

(*Continued on page* 134)

Fertilizer production unit of Land O'Lakes Creameries' Minneapolis plant, before siding was applied

LAND O'LAKES
CREAMERIES INCORPORATED



# from an idea in June to productive operation in January —the Land O'Lakes Fertilizer Plant

In the opinion of several experienced fertilizer producers, time was too short to start from scratch in June 1955 and have a new fertilizer plant in operation to meet the 1956 market demands.

But Land O'Lakes management decided to flash the go ahead sign. In July Blaw-Knox accepted the challenge—to engineer, construct, and install a TVA continuous ammoniation and granulation system in time to produce for the 1956 fertilizer season.

Engineering was well under way in August. Ground broken in September. Structure housed by November. Final installations finished in December. Operation started in early January. Well over 30,000 tons of granular fertilizer produced and sold during spring season of 1956.

That was the tight schedule maintained by Blaw-Knox—in spite of heavy snowfalls and temperatures that dropped at times to 30° below zero.

This was, of course, an unusual assignment. But it demonstrates the ability of Blaw-Knox to handle tough jobs. So when you are considering a modernization, an expansion or a new plant program, we would welcome the opportunity to study your project with you and submit our recommendations.

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**News of the Field**

**FROM LOCAL SECTIONS**

## NEW YORK MEETING . . .

(*Continued from page 132*)

R. Grace. Add to that the new, but growing, concept of contract plant maintenance—is it good for your company or not?

As would be expected, there will be a lot of debate on the Professional Licensing session—in fact it has been set up with pros and cons already being prepared. Chairman J. Lawrence has also arranged for a speaker who will tell the chemical engineers why they may be missing the boat by not registering, what could happen to chemical engineers in the future if they do not license.

## PROGRAM, NEW YORK ALL-DAY MEETING

**HOTEL STATLER, NEW YORK CITY**

### MORNING, OCTOBER 22, 1957

**CONTROL ENGINEERING,** L. E. Skater, executive director, Foundation for Instrumentation Education and Research, presiding.

**The Problem,** E. Johnson, Dept. of Chemical Engineering, Princeton Univ.

The why and how of control systems engineering in chemical plants, giving the fundamentals and how much of these the chemical engineer might absorb in his formal training.

**Some Solutions,** Ted James, Du Pont.

Results of applying the tools and techniques of control systems engineering to existing chemical processes and some work which has been done in the synthesis of new processes.

**Where Solutions Lead,** Albert Sperry, President, Panellit, Inc.

The concept of the "optimized process" and a look into the future to visualize computer-controlled operations with economics and distribution brought into the process loop.

---

**YOU, YOUR EMPLOYER, AND YOUR KNOWLEDGE—LEGALLY DEFINED,** B. Greffath, Engineering Dept., Chemicals Div., Food Machinery & Chemicals Corp., presiding.

**Patents,** E. J. Willey, patent counsel, Patent and Licensing Corp. Div., Flintkote Co.

The legal relationships between employer and employee regarding patents, patent applications, patent assignments, royalties, who owns what.

**Employer-Employee Contracts,** speaker to be announced.

**Company and Trade Secrets,** speaker to be announced.

### AFTERNOON, OCTOBER 22, 1957

**COST ESTIMATION—PLANNING FOR PROFITS,** E. E. Winne, Polymer Chemicals Div., W. R. Grace and Co., presiding.

**Profitability Index for Investments,** R. I. Reul, Chemicals Div., Food Machinery and Chemicals Corp.

A single, simple, accurate and dependable guide for making impartial comparisons of rates of return on investments and so measure profitability.

**Projecting the Profitability of New Products,** T. T. Miller, president, Polymer Chemicals Div., W. R. Grace and Co.

The steps to be taken when determining the profitability of new products based on the distilled experience of several Grace divisions.

**Contract Maintenance—Is It For You?** Alan McCone, Catalytic Construction.

Advantages and disadvantages of contracting for complete plant maintenance service, outlining the savings made in Tidewater's current program.

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**PROFESSIONAL ENGINEERING—CHOICE OR COMPULSION?,** J. Lawrence, president, Lawrence Co., consulting engineers, presiding.

**Professional Engineering and the Chemical Engineer,** Frank Johnson, Con Edison; presi-




## PROGRAM FOR 12TH ANNUAL SOUTH TEXAS SECTION

(*Continued from page 132*)

**MOODY CONVENTION CENTER, GALVESTON**

### MORNING, OCTOBER 18, 1957

**MAINTENANCE AND CONSTRUCTION,** C. J. Kramis, Du Pont, La Porte, Tex., presiding. **Introduction,** C. J. Kramis, Du Pont. **Changing Maintenance Requirements in the Chemical Industry,** O. S. York, Du Pont, Newark, Del.

Maintenance problem is changing in magnitude, character, and significance, and maintenance costs are becoming a more significant ingredient of overall cost.

**Maintenance Planning and Execution,** F. D. Macy, Shell Oil Co., Houston, Tex. **The Use of Models in Design and Construction,** A. E. Michel, Fluor Corp., Los Angeles, Cal.

**The Chemical Engineer's Contribution to Lower Construction Costs,** R. C. Rohdanz, Tellepsen Construction Co., Houston, Tex.

The chemical engineer's true basic function in making economic studies, feasibility studies, and estimates of appropriations required for new facilities. Present role is often too limited.

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**GENERAL SESSION I,** Jack Cinque, American Oil Co., Texas City, Tex., presiding.

**Miscible Displacement Processes in Capillaries,** R. J. Blackwell and D. U. Von Rosenberg, Humble Oil & Refining, Houston, Tex.

Comparison of the mathematical solution with the corresponding experimental observations for miscible displacement processes in a single cylindrical capillary.

**Orifice Mixing—Surface Formation in Immiscible Liquids,** L. S. Scott and C. D. Holland, Texas A&M, College Station, Tex.

Experimental work on the dispersion of one immiscible liquid in another by means of an orifice mixer.

**Calculation of Static and Flowing Bottom Hole Pressures of Natural Gas Wells from Surface Pressure Measurements,** Paul Crawford, Texas Petroleum Research Inst., Texas A&M.

**Mass Transfer Between a Gas Bubble and a Liquid,** Dennis Wade, G. T. McBride, and W. W. Akers, Rice Inst., Houston, Tex. **The Pall Ring—A New Type of Tower Packing,** John Eckert, U. S. Stoneware Co., Akron, Ohio.

### AFTERNOON, OCTOBER 18, 1957

**SAFETY,** R. D. Hornbeck, Alcoa, Rockdale, Tex., presiding.

**Radiation Hazards to Mankind,** Vincent Collins, M.D., Prof. of Radiology, Baylor Univ. College of Medicine, Houston, Tex.

dent of the New York State Society of Professional Engineers.

Why chemical engineers may be missing the boat by not registering, what the advantages are, and what can happen to the chemical engineer if licensing becomes compulsory.

**Professional Engineering and Corporate Practice,** C. J. Wurmfield, consulting engineer, and C. E. McCulloch, vice-president and manager of process plants division, Foster Wheeler Corp.

Under present N. Y. State law, many corporations cannot practice engineering. This law is currently under heated discussion and Wurmfield will represent those who favor the present law against corporate practice of engineering. McCulloch will take the view opposing the present law.

## TECHNICAL SESSION



*On the beach at Galveston, the Buccaneer Hotel will be headquarters for the Texas meeting.*

The nature and magnitude of the radiation hazard, its immediate and late effects.

**Planning for Disasters,** L. J. Grossheim, Shell Oil Co., Houston, Tex.

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**GENERAL SESSION II,** C. L. Umholz, Humble Oil & Refining, Baytown, Tex., presiding.

**Economics of Plant Locations With Respect to Natural Gas Supplies,** L. R. Brooks, Tennessee Gas Transmission Co., Houston, Tex.

Data and statistics on methane-based products and plant locations, ammonia production and plant locations, carbon black data, and other details of the use of natural gas as a chemical raw material.

**Electronic Aids to Chemical Engineering,** R. W. Olson, Texas Instruments, Inc., Houston, Tex.

Techniques, equipment, materials, components, and transducers generally regarded as peculiar to electronics but which may have broader application in chemical engineering.

**Evaluation of Atmospheric Corrosion Rate With Area and Prevailing Wind Throughout an Industrial Plant Site,** C. F. Schrieber, Dow Chemical, Freeport, Tex.

**Phase Equilibria at High Pressures,** D. L. Katz, Univ. of Michigan, Ann Arbor, Mich.

Information on phase diagrams for mixtures, vaporization by compression, reversed solubility, vapor-liquid-liquid equilibria, and vapor-liquid-solid equilibria will be surveyed in the work toward a better set of methods for predicting phase behavior.

*(More Local Section News on p. 136)*





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## News of the Field

FROM LOCAL SECTIONS

### LOCAL SECTION OFFICERS

Continued from the August issue of *CEP*, here are the new officers of more A.I.Ch.E. local sections:

**Central Virginia Section:** S. J. Friedman, chairman; J. P. Haggerty, vice-chairman; G. R. Roe, secretary; and W. R. Horne, treasurer.

**Coastal Bend Section:** J. B. Dahms, chairman; O. L. Culberson, chairman-elect; H. DeKeyzer, treasurer; and R. C. Brandquist, secretary.

**Memphis Section:** T. A. Feazel, chairman; L. C. Skinner, vice-chairman; and L. Roman, sec.-treasurer.

**Midland Section:** J. Eichhorn, chairman; T. Bishop, vice-chairman; J. H. Ashley, secretary; and V. Morello, treasurer.

**Nashville Section:** H. Stewart, chairman; D. Threadgill, vice-chairman; and J. Hunter, Jr., sec.-treasurer.

**National Capital Section:** R. L. Tuve, chairman; F. C. Moesel, vice-chairman; H. B. Peterson, secretary; and V. A. Wente, treasurer.

**New Jersey Section:** J. W. Axelson, chairman; D. Calkins, vice-chairman; J. Yost, secretary; and J. Drew, treasurer.

**New York Section:** T. M. Jackson, chairman; Max Strawn, vice-chairman; Herman Krinsky, secretary; and Elmer Meilun, treasurer.

**Northern California Section:** T. Vermeulen, chairman; Arne Eriksen, vice-chairman; G. H. Goff, secretary; and J. F. Valle-Riestra, treasurer.

**Ohio Valley Section:** K. H. Pettengil, chairman; H. J. Peddicord, vice-chairman; L. Rogovin, secretary; and N. Morley, treasurer.

**Oklahoma Section:** R. E. Weis, chairman; R. A. Koble, vice-chairman; E. W. Henderson, secretary; and S. E. Forsyth, treasurer.

**Syracuse Section:** R. A. Hiserodt, chairman; J. F. Keville, vice-chairman; F. M. Knowlton, secretary; I. W. Wolf, treasurer.

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**Houston will be the site of Tracerlab's 1957 oil symposium November 6-8.** Some twenty papers will cover the applications of radioactivity in petroleum production. Headquarters will be the Shamrock Hotel. □

## INSTITUTIONAL NEWS

**Luncheon speaker at the American Nuclear Society's second winter meeting in New York October 28-30 will be H. D. Smyth,** author of the famous "Smyth Report" on the wartime atomic bomb project, and now the Government's administrator of research programs for the harnessing of atomic and hydrogen reactions as sources of useful power. The luncheon will be on October 29. Subject of Smyth's talk has not been set yet, but will probably deal with some aspect of national progress in the nuclear power field, possibly the Matterhorn Project on atomic fusion. □

**The new and unique $1,525,000 Cleveland Engineering and Scientific Center got off to a fast start** as C. F. (Boss) Kettering joined Ohio's Gov. C. W. O'Neill and Cleveland civic, industrial, and engineering leaders in laying the cornerstone. The new Center will hold the professional and scientific activities of some 20,000 men and women engaged in the technological activities of industry and research in the Cleveland area. □

**"The Canadian Chemical Industry in 1962"** will be theme of the inaugural divisional meeting of the Chemical Economics Division of the Chemical Institute of Canada, Montreal, October 29, 1957, Sheraton-Mt. Royal Hotel. Emphasis will be on trends and growth of the Canadian chemical industry and its development in the next five years. □

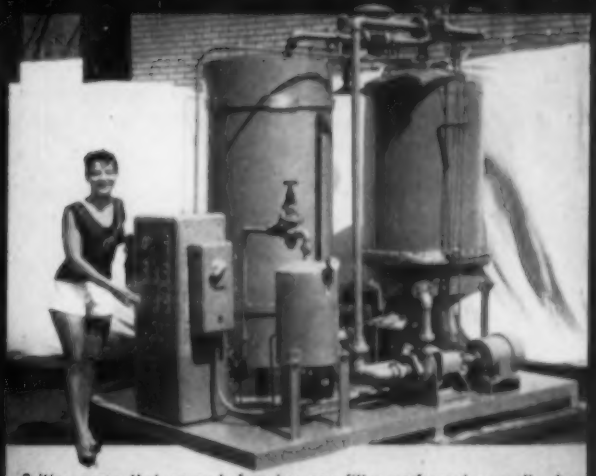
**A new technical publication, the "Annales du Genie Chimique,"** will soon be published. An annual publication, the new periodical will cover original and complete studies of chemical engineering problems. For particulars write: Institut du Genie Chimique, 17 rue Sainte-Catherine, Toulouse, France. □

**A comprehensive handbook on lithium and its compounds** will be prepared by the American Lithium Institute under contract to the Air Research and Development Command's Wright Air Development Center. □

**A reminder: Engineers Joint Council General Assembly,** held this year in conjunction with Engineers' Council for Professional Development, will be in New York October 24-25. □

**A new computing center has been opened in Boston.** The American Center for Analog Computing will provide a complete service for users of analog computing techniques. □


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Critics agree that never before has any filter performed so well — by eliminating particles down to 1/10 of a micron with unequaled flow rates, ClaRite filters combine the highest throughput with brilliant clarity.

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Standard ClaRite filters, offered according to specific requirements in three types of filter membranes, are available with from 5 to 185 sq. ft. of filtration area, constructed of carbon steel, stainless steel, or lined carbon steel. Special designs available for larger or smaller units or for units constructed of other materials. For additional information, write today.

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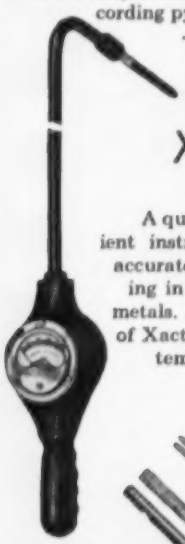
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## INSTITUTIONAL NEWS

**The cornerstone is in place for the new Cleveland Engineering and Scientific Center.** Total cost is estimated at $1,525,000, all but $600,000 has been contributed by more than 250 companies and 3,500 individuals. A cooperative effort on the part of the Cleveland Engineering Society and 51 other member groups of the Cleveland Technical Societies Council, the new Center is expected to supplement existing in-plant training programs and adult education classes in all branches of engineering. □

**"Starting salaries for engineers are still spiraling upward,"** says a report from Illinois Institute of Technology. 1957 starting salaries in all branches for Illinois engineering graduates averaged $473 per month, $82 per month more than the 1956 average. Electrical engineers commanded the most money, $515, while the figure for chemical engineers stood at $458. Industrial interviews per graduate averaged 5.5. □

**An Engineering and Management course, a two-week intenstified program** designed to prepare personnel for higher management responsibilities, will again be held at the University of California, Los Angeles, January 27 to February 6, 1958. Subjects will include General Management Principles, Engineering and Research Administration, Managerial Adjustment to Labor Law and Union Relations, Leadership Principles, and Economics of Plant Investment and Equipment Replacement. Details on course available from Coleman, Engineering Extension, Room 3104, University of Calif., Los Angeles 24, Calif. □

**Britain will hold a National Anti-Corrosion Week from Oct. 14 to 19.** Main London events will be a Corrosion Convention and a Corrosion Exhibition, Oct. 15-17. □

**Accelerated testing of rust preventives, experience with liquid metal corrosion,** and corrosion in the corn wet milling industry, are among the topics to be covered in the Chemical Processing Industries Symposium at the North Central Regional meeting of The National Association of Corrosion Engineers in Chicago Oct. 1-4. Other symposia are refinery corrosion, public utilities, transportation, cathodic protection, pipe line corrosion, protective coatings, and water treatment. □


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**500 key men from industry and education** are expected to attend the 10th Annual College-Industry Conference of the American Society for Engineering Education, University of Michigan, January 30 and 31, 1958. Themes of conference will be industry's need for and utilization of "well-educated and motivated" technical personnel, and the changes being forced on education by pressures from industry and population growth. □

**Illinois Institute of Technology announces the fourth annual Computer Applications Symposium,** sponsored by the Armour Research Foundation, to be held Oct. 24 and 25 at the Hotel Sherman, Chicago. Invited papers, panel sessions, and discussions will cover business and management applications (Oct. 24) and science and engineering applications (Oct. 25). Information available from Secretary, Computer Applications Symposium, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill. □

**"Polyethylene—Properties and Uses,"** will be the subject of a regional technical conference sponsored by the Cleveland-Akron Section, Society of Plastics Engineers, Hotel Carter, Cleveland, Oct. 17, 1957. Morning session will cover properties of the various density polyethylenes, afternoon will be devoted to new uses as described by the major producers. For information contact E. J. Haskins, Zenith Plastics Co., 1009 Rockwell Ave., Cleveland 14, Ohio. □

**Just published is the third Chemical Engineering Library Book List** compiled by the Booklist Subcommittee of the Chemical Engineering Education Projects Committee of A.I.Ch.E. The first revision since 1947, the new list will be a must for college and university departments of chemical engineering, for industrial groups and individuals. Broad in concept, the list contains not only books on chemical engineering *per se*, but on related fields such as chemistry, physics, and other engineering disciplines, and books are rated A (essential), B (highly recommended) and C (should be available). Credit for this essential publication goes to the subcommittee chairmanned by C. A. Walker and consisting of R. V. Allen, R. M. Hubbard, H. P. Munger, and W. R. Pavelchek; and to the former subcommittee members: C. C. Monrad, H. P. Simons, J. M. Peterson, and L. F. Stutzman. Copies may be obtained from A.I.Ch.E., 25 West 45th Street, New York 36, N. Y. Cost: $1.00. □


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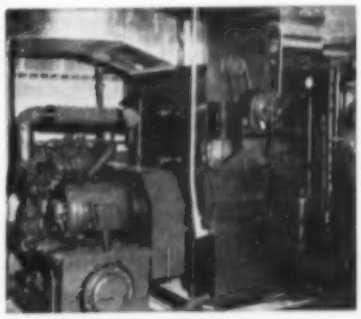
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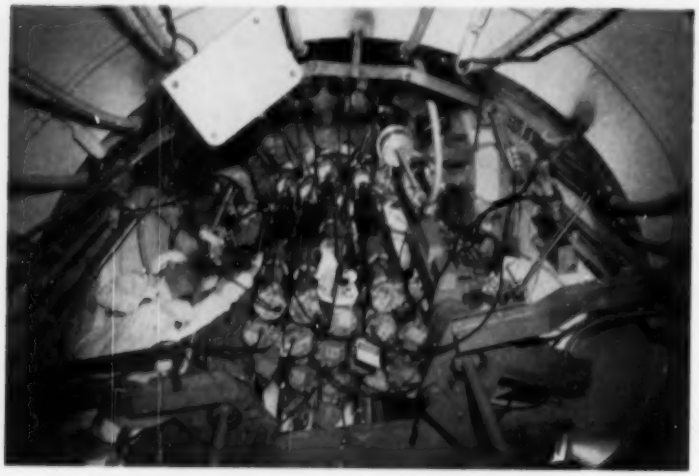
## LARGEST TITANIUM INGOT

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## NERVE CENTER

is this control rod mechanism at extreme bottom end of Engineering Test Reactor, looking up from access room. Reactor is at Idaho Falls, Idaho installation of AEC.



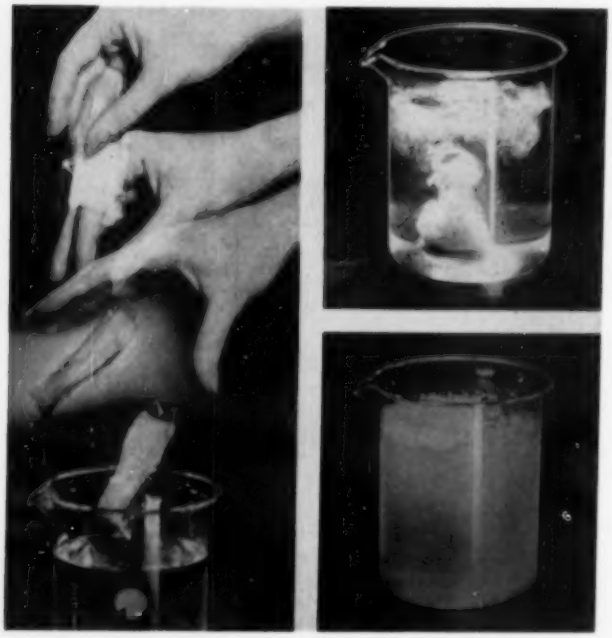


## RADIOISOTOPE—EXCITED LAMP

Perhaps comparable to Edison's first carbon-filament incandescent lamp is U. S. Radium's new $Kr^{85}$-excited commercial lamp which provides marking illumination for periods of up to 10 years or more, with no power or maintenance required. Model shown emits 1,000 microlamberts brightness, is clearly visible at 500 yards. By using different phosphors, lamps emitting different colors can be supplied.

## DISSOLVABLE PACKETS

will soon contain detergents, fertilizers, paints and tints, anti-rust agents, insecticides, and other water dispersable products, according to Reynolds Metals, manufacturer of the polyvinyl water-soluble film used.

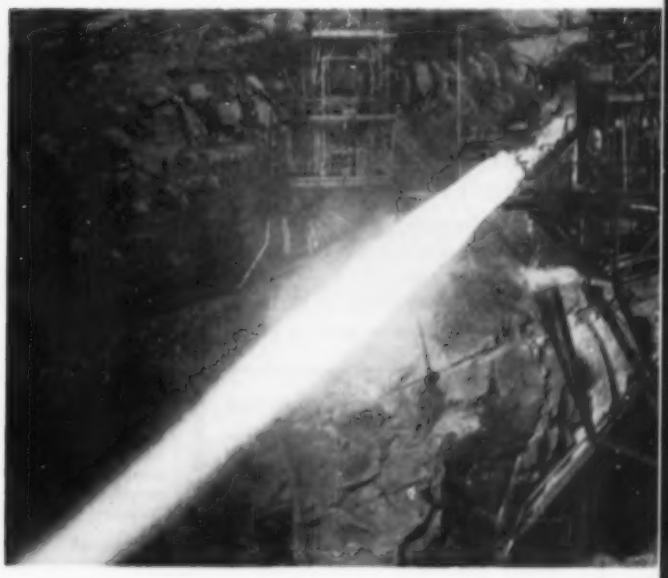




## LIQUID PROPELLANT ROCKET ENGINE TEST STATION TO BE VISITED



in October by fortunate members of the A.I.Ch.E.'s Southern California section. Operated by North American Aviation's Rocketdyne Division, this test station is just west of the San Fernando Valley. It is said to be the free world's most active and advanced installation for research, development, and acceptance testing of large engines for such supersonic guided missiles as Atlas, Thor, Redstone, and Jupiter.



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Chicago's skyline from Lake Michigan. In foreground, Grant Park. To left, Conrad Hilton hotel; to right, new Prudential building.

## FUTURE MEETINGS

**MEETINGS** **SYMPOSIA**

■ **BOSTON, MASS.**

October 9-11, 1957, Hotel Somerset. **Fourth National Symposium on Vacuum Technology,** sponsored by the Committee on Vacuum Techniques. Approximately twenty-five papers covering fundamental advances in vacuum technique, means of producing, measuring, and conducting low pressures, and advances in application of vacuum to processing.

■ **ATLANTIC CITY, NEW JERSEY**

October 16-18, 1957, Chalfonte-Haddon Hall Hotel. Conference on **Computers in Control.** Sponsored by A.I.E.E. with participation by I.R.E. and A.S.M.E. About 35 technical papers by leading scientists in this country and abroad.

■ **NEW YORK, N. Y.**

October 24 and 25, 1957, Statler Hotel. **The General Assembly,** a joint meeting sponsored by Engineers' Council for Professional Development and Engineers Joint Council. Thursday, October 24: **Military Service and Professional Development; The Community College and Technological Education.** Friday, October 25: **The Place of the Engineer in Industrial Management; New Dimensions in Post-Graduate Education for the Young Engineer.**

■ **NEW YORK, N. Y.**

October 28-November 1, 1957, New York Coliseum and Henry Hudson Hotel, Plaza Hotel, and Waldorf-Astoria Hotel.

**International Atom Week.** Trade fair and series of conferences and meetings sponsored by Atomic Industrial Forum, American Nuclear Society, Institute of Radio Engineers, and the A.E.C.

■ **ANNUAL—CHICAGO, ILL.**

December 8-11, 1957. Conrad Hilton Hotel.

TECHNICAL PROGRAM CHAIRMAN: Henry F. Nolting, Standard Oil Co., 2400 New York Ave., Whiting, Ind. For program details see page 114.

■ **1958 MEETINGS**

• Chicago, Ill., March 17-21, 1958.

1958 Nuclear Congress. Managed by A.I.Ch.E. Coordinated by E.J.C. Will include: 4th Nuclear Engineering and Science Conference, 4th International Atomic Exposition, 6th Atomic Energy in Industry Conference, 6th Hot Laboratories and Equipment Conference, and the American Power Conference.

• Montreal, Canada, April 20-23, 1958. Sheraton-Royal Hotel. Joint A.I.Ch.E.-C.I.C. Conference. A.I.Ch.E. CHAIRMAN: Kenneth Beatty, North Carolina State College, Raleigh, N. C. CO-CHAIRMAN: W. H. Gauvin, McGill University, Montreal. **Chemical Engineering Aspects of Heavy Water Power Reactors**—CHAIRMAN: Donald Stuart, Evaluation Section, Civilian Power Reactors Branch, A.E.C., Washington 25, D. C. CO-CHAIRMAN: W. M. Campbell, Canadian A.E.C. **Chemical Engineering Methods in Mineral Processing**—CHAIRMAN—F. A. Forward, University of British Columbia, Department of Mining & Metallurgy, Vancouver 8, B. C. **Fluid Mechanics**—CHAIRMAN: S. G. Mason, Dept. of Chemistry, McGill Univ., Montreal, P. Q. **Noise in the Chemical Industry**—CHAIRMAN: G. Thiessen, Physics Division, National Research Council, Ottawa, Ontario. **Chemical Engineering Technology in the Pulp and Paper Industry**—CHAIRMAN: L. R. Thiesmayer, Pulp and Paper Research Institute of Canada, 3420 Univ. St., Montreal, P. Q. **Future Sources of Energy**—CHAIRMAN: J. W. Hodgins, Director of Engineering Studies, Hamilton College, McMaster Univ., Hamilton, Ontario. **Modern Chemical Plant Construction Techniques**—CHAIRMAN: S. A. Guerrieri, Lummus Co., 385 Madison Ave., New York 17, N. Y. **General Papers**—CHAIRMAN (pro tem): W. H. Gauvin, Dept. of Chemical Engineering, McGill Univ., Montreal, P. Q. Special panel discussion (Sunday afternoon, April 20, 1958)—**Chemical Engineering Education in the United States and in Canada**—MODERATOR: W. G. Whitman, Dept. of Chemical Engineering, M.I.T., Cambridge, Mass.

• Philadelphia, Pa. June 22-27, 1958. Bellevue-Stratford Hotel. A.I.Ch.E. Fiftieth Anniversary Meeting. CHAIRMAN: Roy Kinckiner, DuPont, Wilmington, Del. Theme for program is: **A Look to the Future.** All symposia and papers are being planned in accordance with this theme. **Fluid Mechanics, Heat and Mass Transfer**—Organizer: C. R. Wilke.

• August 18-21, 1958. A.I.Ch.E.-A.S.M.E. Heat Transfer Conference. CHAIRMAN: A. S. Foust, Dept. of Chem. Eng., Lehigh University, Bethlehem, Pa.

• Salt Lake City, Utah, Sept. 21-24, 1958. A.I.Ch.E. Nat'l. Meeting. CHAIRMAN: E. B. Christiansen, Dept. of Chem Eng., Bldg. 437, Univ. of Utah, Salt Lake City. **Air Pollution**—CHAIRMAN: W. L. Faith, Air Pollution Foundation, 704 S. Spring St., Los Angeles 14, California. **What's New in Liquid Metals Technology**—CHAIRMAN: Marshall Sittig, American Lithium Institute, Inc., P.O. Box 549, Princeton, N. J. **Crystallization**—ORGANIZER: C. S. Grove, Jr., Director of Engineering, Syracuse Univ. Research Institute, Syracuse 10, N. Y. **Foams and Froths**—ORGANIZER: J. Louis York, Dept. of Chemical Engineering, Univ. of Mich., Ann

## ■ 1958 MEETINGS (Cont.)

Arbor, Mich. **Ethylene**—ORGANIZER: Hermann C. Schutt, 201 Devonshire Street, Boston, Mass.

• Cincinnati, Ohio, December 7-19, 1958. **Netherland Plaza Hotel. A.I.Ch.E. Annual Meeting. TECHNICAL PROGRAM CHAIRMAN: A. C. Brown, Emery Industries, Inc., June & Long Streets, Ivorydale, Ohio. Water Pollution**—C. Fred Gurnham, Dept. of Chem. Eng., Michigan State U., East Lansing, Michigan. **Distillation**—CHAIRMAN: W. C. Schreiner, M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y. **High-Speed and Time-Lapse Photography in Chemical Engineering**—CHAIRMAN: J. W. Westwater, William Albert Noyes Laboratory, Univ. of Illinois, Urbana, Ill. **Kinetics & Rate Processes**—CHAIRMAN: H. E. Hoelscher, Dept. of Chem. Eng., John Hopkins Univ., Baltimore 18, Md. **New Approaches for Commercial Chemical Development**—CHAIRMAN: H. E. Wessel, Monsanto Chemical Co., 1700 South Second Street, St. Louis, Mo. **Reprocessing of Fluid Reactor Fuels**—CHAIRMAN: O. E. Dwyer, Chemical Engineering Division, Brookhaven National Laboratory, Upton, L. I., N. Y. **The Application of Computers to Heat and Mass Transfer Problems**—CHAIRMAN: J. M. Smith, Northwestern Univ., Evanston, Ill.

## ■ 1959 MEETINGS

• Kansas City, Mo., May 10-13, 1959. TECHNICAL PROGRAM CHAIRMAN: Fred Kurata, Chemical Engineering Dept., Univ. of Kansas, Lawrence, Kansas.

• San Francisco, Calif., December, 1959. TECHNICAL PROGRAM CHAIRMAN: C. R. Wilke, Division of Chemical Engineering, Univ. of California, Berkeley, Calif.

## UNSCHEDULED SYMPOSIA

*Correspondence on proposed papers is invited. Address communications to the Program Chairman listed with each symposium below.*

• **Centrifugation:** James O. Maloney, Dept. of Chem. Eng., U. of Kansas, Lawrence, Kans. The theory and quantitative aspects of centrifugation.

• **Size Reduction:** Edgar L. Piret, Chem. Eng. Dept., U. of Minnesota, Minneapolis 14, Minn.

• **Filtration & Centrifugation:** Horace Hinds, Jr., Basic Vegetable Prod. Co., Vacaville, Calif.

• **Chemical Engineering Process Dynamics as They Affect Automatic Control:** David M. Boyd, 315 Ridge Ave., Clarendon Hills, Ill.

• **Dry Classification of Solids:** D. W. Oakley, Metal & Thermit Corp., Carteret, N. J.

• **Statistics in Chemical Engineering:** John C. Whitwell, Princeton University, Princeton, N. J.

• **Education of Chemical Engineers:** F. M. Tiller, Dean of Eng., University of Houston, Cullen Blvd., Houston 4, Texas.

• **New Chemical Engineering Construction Techniques:** S. A. Guerrieri, The Lummus Co., 385 Madison Ave., N. Y. 17.

• **Mineral Process Engineering and Mineral Economics:** L. A. Roe, International Minerals & Chemical Corp., 20 North Wacker Drive, Chicago 6, Ill.

• **Foams and Froths:** J. L. York, Dept. of Chem. & Met. Eng., Univ. of Mich., Ann Arbor, Michigan.

• **Thermodynamics of Phase-Equilibria:** E. H. Amick, Dept. of Chemical Engineering, Columbia Univ., N. Y.

• **Properties of Liquids:** S. E. Isakoff, Engineering Research Laboratory, Du Pont, Wilmington, Del.


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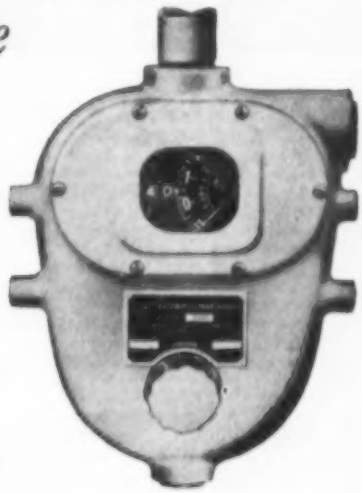


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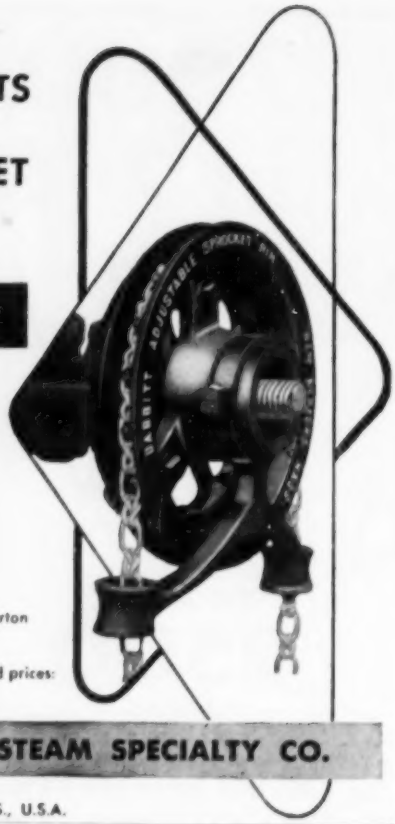
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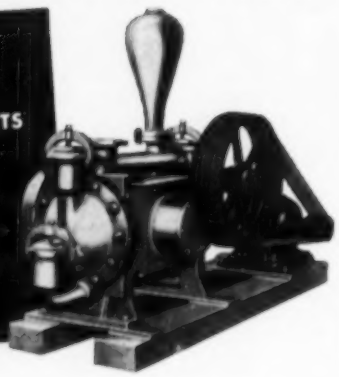


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## INSTITUTIONAL NEWS

**The National Association of Corrosion Engineers** will hold a South Central Region meeting in Oklahoma City, Oct. 1-4; a North Central Region meeting in Chicago, Oct. 2-4; a Northeast Region meeting in Pittsburgh Nov. 12-14; and a Miami Section short course Nov. 13-16 at Key Biscayne, Fla. □

**The Second Winter Meeting of the American Nuclear Society will be held in New York City** October 28-31. Headquarters will be the Henry Hudson Hotel. □

**Twelfth Annual Instrument Society of America Instrument-Automation Conference and Exhibit was held Sept. 9-13** in the Cleveland Auditorium, Cleveland, Ohio. Organized under the theme, "Instruments for Systems Control," the conference featured such nationally known instrument men as Simon Ramo, executive v-p, Ramo-Wooldridge, and Cuthbert Hurd, director of central research, IBM. □

**The Second World Metallurgical Congress, sponsored by the American Society for Metals, will be held in Chicago November 2-8, 1957.** An attendance of at least 650 metal scientists from 36 countries is expected. Largest foreign contingent will be Great Britain's 95, followed by Germany's 88 and Japan's 65. The 39th Annual National Metal Exposition and Congress will be held at the same time and place with more than 50,000 expected to attend. □

**The 26th Chemical Exposition will be held in New York December 2-6, 1957.** More than 500 exhibitors will occupy all four floors of New York's Coliseum. Just announced is the name of the chairman of the advisory committee. He is E. R. Weidlein, trustee of the Mellon Institute. Representing A.I.Ch.E. on this committee is president J. Henry Rushton. □

**Male advantage in basic engineering aptitude tests is only 3 to 2 over women, according to a 1956 report of the Dept. of Labor.** Quoting this report, Emma C. Barth, an engineer in the rotating apparatus department of Westinghouse's East Pittsburgh plant, charged discrimination against women in engineering, emphasized that while we are going to need many more engineers in the near future, women are being discouraged from entering the field. □

# people

New members of the Process Study Group of Hooker Electrochemical Co., Niagara Falls, N. Y., are **William O. Dietsche, Stanley Field,** and **Richard G. Woodland.**

At A. E. Staley Manufacturing Co., Decatur, Ill., **William R. Armstrong** will head a newly-formed Grocery Products Development Research Group, and **Harold D. Allen** will be in charge of the Process Research Group.

Key personnel changes in Monsanto Chemical's Organic Chemicals Division include: naming of **Dominic Danna** as general superintendent of warehouse and inventories at Monsanto's John F. Queeny plant in St. Louis; appointment of **Paul W. Edwards** as plant manager at Avon, Calif.; and appointment of **Paul A. Kannapell** as general manufacturing superintendent at the Queeny plant.

**Frank J. Soday,** vice-president and director of research and development of Chemstrand Corp., Decatur, Ala., elected chairman of the Board of Trustees of the Southern Association of Science and Industry.

Promoted to fill newly-created positions in Continental Oil Company's Petrochemical Department are: **J. G. Hough** to assistant general manager; **Paul E. Geiser** to manager of the department's Detergents Division; and **W. B. Strobel** to manager of the department's Chemicals Division.

**Jack Hatcher** has joined the Maytag Co., Newton, Iowa, as a chemical engineer in the process control laboratory.

Atlas Powder Co. announces appointment of **Harry A. Quigley** as an economic evaluation engineer. Quigley comes to Atlas from General Foods Corp. Research Center, Tarrytown, N. Y., where he served two years in the Engineering Research Department.

**John T. Selldorff** joins staff of Arthur D. Little. Selldorff, formerly associated with Carbide and Carbon Chemical Co. and with Linde Air Products, will be a member of the Engineering Division, working in the field of applied thermodynamics.

(*Continued on page* 146)


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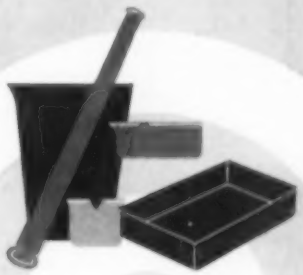
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## McADAMS HONORED AT JOINT A.I.Ch.E.-A.S.M.E. HEAT TRANSFER CONFERENCE



On the occasion of the First National Heat Transfer Conference held recently at Pennsylvania State University, the A.I.Ch.E. and the A.S.M.E. joined to pay tribute to Professor W. H. McAdams of M.I.T. (speaking, above) in recognition of his pioneering contributions to the field of heat transfer. Speakers at the honor banquet were W. F. Ryan, president of A.S.M.E., F. J. Van Antwerpen, secretary of A.I.Ch.E., T. B. Drew of Columbia University, and S. D. Kirkpatrick of McGraw-Hill Book Co. The latter, on behalf of McGraw-Hill, presented Professor McAdams with a specially-bound, de luxe edition of his classic book on heat transfer.

---

Badger Manufacturing Co., Cambridge, Mass., names **Anson W. Krickl** as general manager of manufacturing. Krickl comes to Badger from Catalytic Construction Co., Philadelphia, where he was assistant to the president in charge of new business.



Krickl

**John J. Glover,** manager of market research for Jefferson Chemical since 1955, will head that company's newly-formed Commercial Development Division as general manager. The new division at Jefferson combines the Market Research Division and the Sales Research and Development Division.

Blaw-Knox has named **Hal B. Coats** as assistant manager in the Chemical Plants Division. In his 15 years with Blaw-Knox, Coats has served as research and development director of the Chemical Plants Division and manager of the Atomic Energy Department. In 1956, he was general chairman of the Pittsburgh National Meeting of the A.I.Ch.E.



Coats

Promotions in Chemstrand Corp.'s Engineering Division include: **R. E. Wright** to manager of Major Projects Department; **Eugene Negro** to manager of Process and Planning Department; **A. T. Bogen** to superintendent of the Planning Section; **George Malinoff** to superintendent of the Process Section; and **A. B. Terry** and **W. H. Washington** to senior supervising engineers.

**Gordon P. Hungerford,** formerly research manager of American Machine and Foundry, has been appointed vice-president of the Kordite Co., division of Textron, Inc., where he will head all research and engineering activities.



Hungerford

**E. A. Clarke** promoted to senior chemical engineer in the Engineering Division at Humble Oil & Refining Company's Baytown, Texas, refinery.

**John D. Keane** named director of research and executive secretary of the Steel Structures Painting Council, a non-profit research organization at Mellon Institute. Keane comes to the Council from the Armour Research Foundation in Chicago.

**A. B. Chadwick** has been named director of manufacturing for Velsicol Chemical Corp. Prior to his present appointment, Chadwick worked in supervisory and executive chemical manufacturing positions with Allied Chemical and Dye, Pennsylvania Coal Products, and Koppers Co.



Chadwick

**L. C. Kemp, Jr.,** becomes vice-president in charge of the Petrochemical Department of the Texas Co. Kemp has been associated with Texaco since 1929.

International Minerals and Chemical Corp. announces appointment of **Bryce L. Rhodes** as general manager of their Phosphate Chemicals Division. Also at International, **M. B. Gillis** has been named director of research and **William C. Knopf** assistant director of research.

**Frederick W. Smith** promoted from supervisor of chemical engineering research to manager of chemical engineering research and semi-commercial chemicals in Research and Engineering Division of Wyandotte Chemicals Corp.

**James H. Worth** has been made assistant general manager of the Chemical Division, Celanese Corp. of America. Prior to his new assignment, Worth served as director of the division's Technical and Economic Evaluation Department. Succeeding Worth as director of technical and economic evaluation is **Robert L. Mitchell,** former director of engineering research at the Chemical Division's Research and Development Laboratories, Corpus Christi, Texas.



Worth



Mitchell

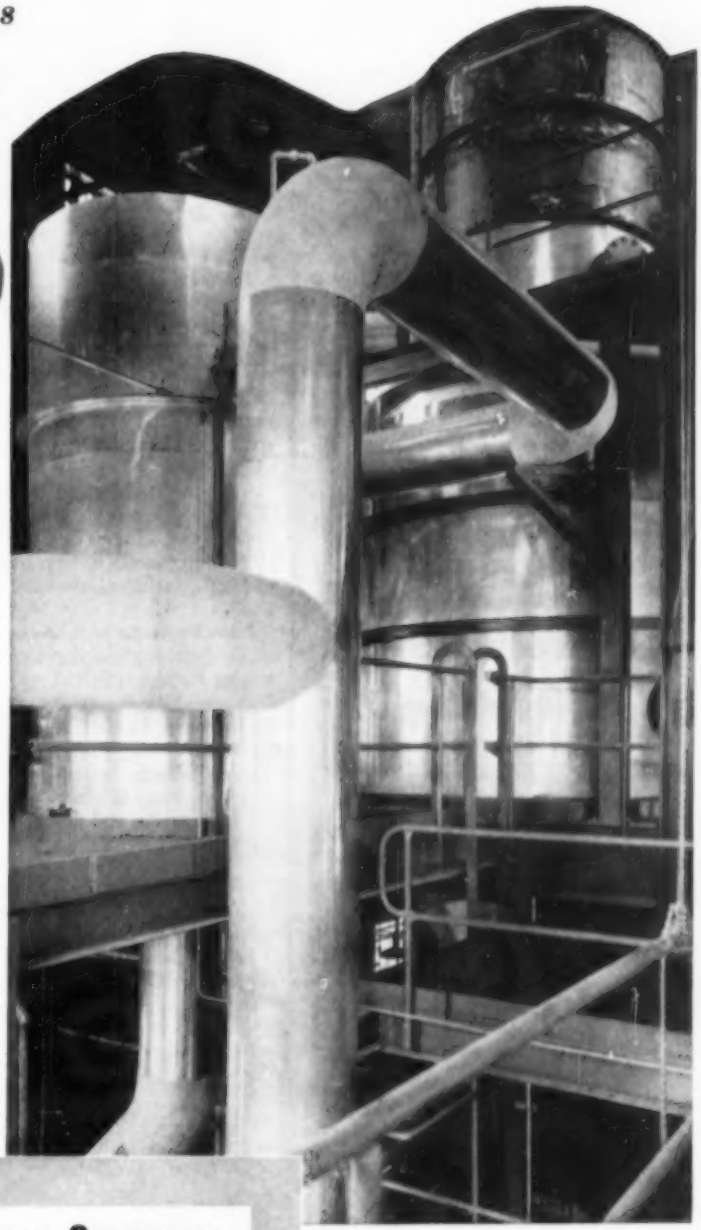
New appointments in the Development Department of Union Carbide Chemicals Co. include: **C. A. Carter, G. L. Funk, E. F. Hillenbrand, Jr., P. C. Johnson, R. E. Leech,** and **C. R. Welter** as assistant directors and **H. J. Jackson** as development area supervisor.

**Benjamin T. Brooks,** engineering consultant of New York, was recently made an Honorary Life Fellow of the Institute of Petroleum, London, England.

*(Continued on page 148)*

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# people

**W. E. Hanford,** formerly vice-president and director of M. W. Kellogg, becomes assistant to the president for research at Olin Mathieson Chemical Corp. Hanford, who holds more than 100 patents in the U. S., has made important contributions to the development of nylon, polyethylene, polyester, elastomers, and acetylene chemistry.



Hanford

Carborundum Co. promotes **Richard S. Bingham, Jr.,** to post of supervising engineer, Quality Control Branch, Research and Development Division.

**F. A. Zenz** has been appointed assistant manager of the Process Department at Walter Kidde Nuclear Laboratories, Garden City, N. Y.

Armour Research Foundation of Illinois Institute of Technology announces that **Henry L. Cox,** specialist in food technology, has joined their staff as a technical consultant.

**John P. Sachs** will be new director of product engineering and development at Patterson Foundry and Machine Co. Sachs comes to Patterson from Visking Corp., where he was supervisor of chemical process engineering and development.



Sachs

**Nathan P. Vahldieck** named to staff of Tonawanda, N. Y., laboratories of the Linde Co. His present assignment is in the Chemical Engineering Development Section of the engineering laboratories.

New chief chemical engineer of Stone & Webster Engineering Corp. will be **Theodore E. Casselman, Jr.** Casselman joined Stone & Webster in 1935 as a project engineer, and in 1953 was promoted to senior project engineer.



Casselman, Jr.

Officers and directors of Badger's new Canadian subsidiary, Canadian Badger Co. Ltd., are: **John C. Starr,** president and director; **Adrian J. Broggini** and **William C. Rousseau,** directors.

(*Continued on page* 150)


**WENDNAGEL**
**PROCESSING & STORAGE EQUIPMENT OF WOOD**

***Prompt Shipments Possible Through Large Production Capacity***

- **Corrosion resistant.**
- **Constructed for long life and low maintenance.**
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only IR Chemical Pumps give you this

## TRIPLE PROTECTION

***. . . against corrosion***

All liquid-handling parts are made of IRCAMET — highly resistant to both acids and alkalis.

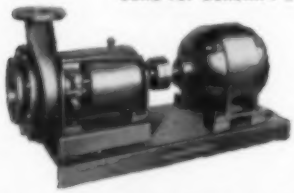
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A patented LEAKOLLECTOR stuffing-box gland drains off any seepage around the shaft.

***. . . against down-time***

All I-R Chemical Pumps are designed and built for easy maintenance and *less of it*.

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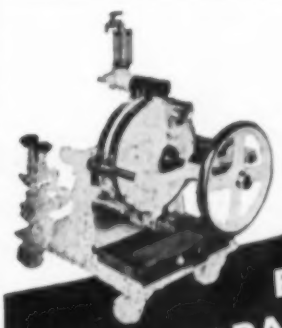


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**EBW Model Filter**

Equipped with 3 gpm pump and electric motor. Stainless steel or bronze nickel plated circulatory system. Holds 4 to 8, 12-1/4" dia. disks.

## Ertel Portable SMALL CAPACITY FILTERS

EFS-B filter is recommended for small batches where sludge or filter aid is required. Also advantageous because no rubber washers are required . . . the asbestos sheets form their own seal. The EBW filter is ideal for high polishing filtration using filter pads.

**ERTEL ENGINEERING CORP.**

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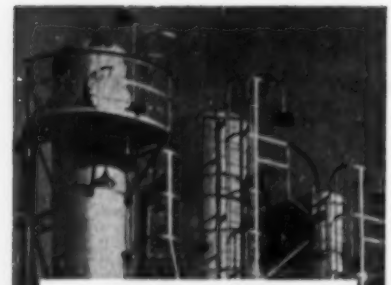
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ERTEL



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Designed for use with any type filtering medium, 12" x 12" square. Single hand wheel provides trouble-free operation. Bronze nickel plated or stainless steel circulatory system.



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■ During the many years AMERICAN AGILE has worked in corrosion-resistant plastics, its outstanding reputation was built upon its performance in research, development and quality controlled production of plastics for the chemical process industries.

• In 1949 as one of the nation's first commercial processors of polyethylene, American Agile evolved the techniques of molding and fabricating the plastic.

• In 1950 Agile introduced the spraying and forming of polyethylene structural shapes to meet operating conditions in which other materials failed. Also, Agile introduced coating of metal targets with modified polyethylene.

• In 1951, welding of polyethylene and polyvinyl chloride was introduced in this country by Agile which then made the techniques and the welding equipment available to other processors.

• In 1954 another Agile first was the introduction of irradiated polyethylene molded parts whose range of industrial applications was enlarged through the exposure to atomic radiation.

• AND TODAY — with still another first in foam polyethylene and polyethylene filter cloth for high temperature applications, American Agile is expanding both research and production to meet the demands of cost-conscious, progressive thinking designers, engineers and management for more efficient production equipment and for better quality products at lower cost.

What Are Your Needs? Whatever your product may be, you will find American Agile a prime dependable source of supply for your processing equipment requirements.

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AGILENE AGILIDE

*Established in 1932*

**AMERICAN AGILE Corp.**

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# people

New staff members of Esso Research and Engineering Co., Linden, N. J., are **Jerrold D. Atlas, Robert J. Onufer,** and **John J. Fitzsimmons.**

**Raymond L. Copson** becomes assistant to the director of development, Solvay Process Division, Allied Chemical & Dye Corporation. Copson, who is technical program chairman for the just-held A.I.Ch.E. National Meeting in Baltimore (September, 1957), was formerly in charge of research and development for Mutual Chemical at their Baltimore Laboratory.

**L. A. Bullington** has been promoted to technical specialist and **R. F. Pfennig** has been named section head in the Technical Service Division at Humble Oil & Refining's Baytown, Texas, refinery.

**John R. Bowman,** research director of the Mellon Institute for Industrial Research, and **Lyman C. Craig,** member of the Rockefeller Institute for Medical Research, have been elected to the Board of Trustees of the Gordon Research Conferences.

New members of the staff of the Whiting Research Laboratories of the Standard Oil Co. (Indiana) are **John C. Heidler, John G. Cladakis, Robert J. Fahrig, Madison E. Marks, Calvin W. Kroop,** and **Robert E. Olson.**



**Harold G. Weber,** professor of chemical engineering at M.I.T., receives a Certificate of Achievement for his "invaluable contribution to the Army Chemical Corps and the National Defense Effort from 1940 to 1957." Weber has been chairman of the Chemical Corps Advisory Council since 1955, and an advisor to the Chemical Corps for the last seventeen years.

**Charles L. Schmidt** appointed technical director of the Titanium Division of National Lead Co. Other recent changes at National Lead include naming of **James H. Noyes** as plant manager of the National Lead-operated A.E.C. installation in Fernald, Ohio, and appointment of **Roy Dahlstrom** as director of research for the company.

Union Carbide Chemicals Co. names **L. D. Polderman** to post of manager of Engineering Services, Technical Service Department. Polderman has been associated with Union Carbide since 1936.

## the chemical engineer in MARKETING

Reynolds Metals Co. has named **L. S. Beeler** as assistant manager of chemical and petroleum market sales. For the past five years, Beeler has been chemical products supervisor for Reynolds.



Beeler

Sales policy and direction of the newly-formed chemical division within Goodyear International Corp. will be in the hands of **Herman R. Thies,** general manager of the company's Chemical Division. The new division will handle overseas sales of synthetic rubber, rubber chemicals, plastic raw materials, and coating raw materials. **R. E. Workman,** appointed manager of the new division, has been awarded a one-year Sloan Fellowship to M.I.T.

**David Trageser,** formerly with Dewey & Almy Chemical Co., is now associated with the sales force of High Voltage Engineering Corp. as a radiation chemist.

**Charles L. Gillingham** named junior sales representative of plastic materials for B. F. Goodrich Chemical Co. Gillingham, who joined Goodrich in March, 1957, was previously with Harris-Seybold Co. in an engineering and sales capacity.

Newly-appointed area representative for Callery Chemical Co. is **W. A. Valentine.** Valentine will be located in the Los Angeles area.



Meginnes

**Charles E. Meginnes** will be new sales manager for industrial chemicals at Davison Chemical Co. Meginnes was formerly assistant sales manager at Davison.

(*Continued on page* 152)

## Additional

# Candidate for A.I.Ch.E. Office

**DIRECTOR FOR 3-YEAR TERM BEGINNING 1958**

**— NOMINATED BY PETITION —**



O'Connell

**H. E. O'Connell**—(Baton Rouge Section)—Industrial executive. Project manager ('56-) Ethyl Corp., Baton Rouge. Res. engr. ('39) Univ. of Michigan. Chem. engr. ('41-'43), superv. ('43-'47), hd. proc. des. & proc. engrg. ('47-'51), assoc. dir. proc. devel. ('51-'56), project mgr. ('56-) Ethyl Corp. Author on dist. & ht. trans. A.I.Ch.E. activ. Committees—Local sect. ('48-'52), Research ('52-'55), Program ('50-'56). Program chmn. Atlanta mtg. ('52), sympos. chmn. Washington mtg. ('54), program chmn. New Orleans mtg. ('56). Chmn. Baton Rouge Sect. ('47).

***Brief biographical sketches of other candidates for Fall 1957 A.I.Ch.E. elections appeared in the August issue. Candidates are chosen by the Nominating Committee unless otherwise designated as nominated by petition. Additional details on each candidate's education and career are available upon request from the Secretary's Office. Further nominations by petition may be received until October 7, and any so received will be announced with brief biographical sketches in the next available issue of C.E.P. Ballots will be mailed from the Secretary's Office in October. It is recommended that members check the October issue of C.E.P. for last-minute petition-nominee announcements.***


# BUDGETING?... make the "two-way" test

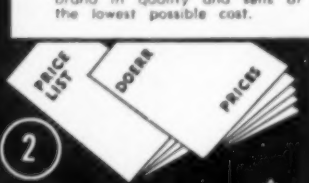


**Whether you are responsible for budgets or not, management is always interested in reducing costs. The "TWO-WAY" Test is designed to help you select the highest quality glassware for the lowest possible cost.**

**THIS IS THE "TWO-WAY" TEST !**

**STEP 1.** Collect several samples of advertised brands of laboratory glassware making sure that one of them is Doerr Diamond D Blue Line. Test these samples for the qualities and characteristics you require in your laboratory and record the results.

**STEP 2. Compare the prices** of the brands tested. You will find the Doerr Diamond D Blue Line outstrips every competitive brand in quality and sells at the lowest possible cost.




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Vineland, N. J.



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Large savings are being gained by many industries using *enclosed* motors in place of the usual "open" or ordinary protected motor. U.S. Totally Enclosed gives *total* protection in every direction—from corrosion, dusts, abrasives, impact, weather, spray and splash! This means motor dependability... long life ... savings both on motor costs and production continuity!

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***Protected*** **BY LUBRIFLUSH FOR LONGER BEARING LIFE**
New grease forces old grease out—keeps bearings fully lubricated. *Protects* bearing efficiency!



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Nature's greatest heat resistor, asbestos can't carbonize! *Protects* windings against heat!



***Protected*** **FROM STRESS AND WARP BY NORMALIZING CASTINGS...**
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*For complete information about* TOTALLY-ENCLOSED MOTORS.

**U.S. Electrical MOTORS**

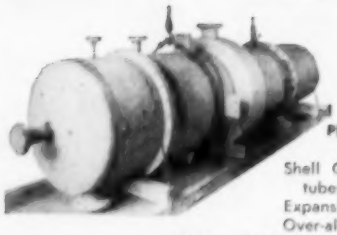
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**Code Construction:** A.S.M.E.
**Materials:** #316 Stainless steel tubes, tube sheets and heads.
**Physical Dimensions:** Total surface: 1600 sq.ft. Shell O.D. 44"—over 400 1½" tubes
Expansion joint O.D. 57"—
Over-all length: 19'6"
**Design Working Pressure:** Shell Side—90 lbs.
Tube Side—50 lbs.

Here is another example, among the thousands of case histories in our files, of how Manning & Lewis clearly and logically interpret customers' requirements . . . from original concept to finished quality product.
Both the saving in time and cost resulting from our years of engineering experience are two important factors why more and more manufacturers are turning to M & L.
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# the chemical engineer in

## MARKETING

**E. Newbold Black, 4th,** named product sales engineer, Chemicals Division, Houdry Process Corp. Black was formerly assistant chemical engineer in the Development Department of the company's Research Division, Linwood, Pa.


Rice

New general sales manager for Fischer & Porter Co. will be **Robert L. Rice.** Rice joined Fischer & Porter in 1950 as a sales engineer.

**John H. Dea** becomes assistant to the president of the Texas Co. Dea was formerly assistant manager of the Sales Division of Texaco's Foreign Operations Department, Western Hemisphere and West Africa.

**Jerome T. Coe** appointed manager of marketing for the Silicone Products Department, General Electric Co. Coe, who joined General Electric in 1942, has been associated with the silicone operation since 1946.

Catalytic Construction Co. names **Raymond Wynkoop** as manager of sales. Wynkoop, widely experienced in the chemical and petroleum fields, has formerly been associated with Publicker Industries of Philadelphia, Standard Oil Co. (Indiana), Algonquin Chemical Co., National Distillers and Chemical Co., and Houdry Process Corp.

**H. W. Eumont, Jr.** has recently joined the marketing group of the newly-formed Amoco Chemicals Corp., new chemical subsidiary of Standard Oil of Indiana. Eumont is presently located in the firm's Chicago general office.

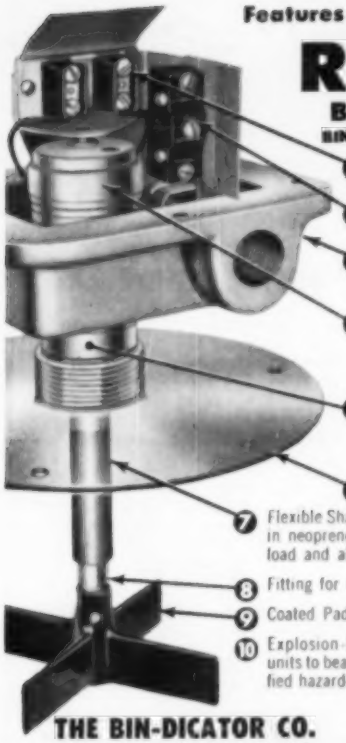
# Necrology

**Roy B. Johns,** 64, vice-president and sales manager of Freeport Sulphur Co.

**George G. Brown,** 60, dean of the College of Engineering, University of Michigan. Brown had long been active in A.I.Ch.E. affairs, having been president in 1944, treasurer since 1953, and a director from 1940 to 1952. An appreciation appears on the editorial page of this issue of *CEP* (p. 407).

Features of the Improved

# ROTO-
## BIN-DICATOR
BIN LEVEL INDICATOR



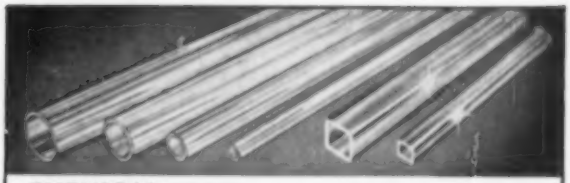
1. H.D. Terminal Block; easy connections.
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3. Dust-tight gray iron housing; std or exp. proof.
4. Low Torque Motor supported on 2 bearing points for protection from vibration.
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8. Fitting for easy shaft extension.
9. Coated Paddle resists abrasion.
10. Explosion-Proof Models; first and only units to bear U.L. Label for use in specified hazardous atmospheres.

**THE BIN-DICATOR CO.**
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**CHEMICAL ENGINEERS!**

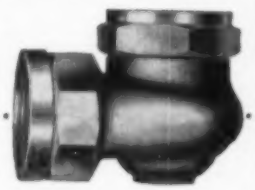
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B.S. or M.S. degrees in Chemical or Mechanical Engineering with at least four (4) years experience in design of chemical plant and/or processing equipment.

Responsibilities include design, selection of equipment, and coordination of all aspects of engineering projects from conception to completed installations.

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*Compensation commensurate with education and demonstrated qualifications.*

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Opportunities in **Research and Development**

. . . . . Equipment and Process Design
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Openings are technically challenging and offer good advancement possibilities. Location is in Suburban Philadelphia.

Applications are invited from B.S. and M.S. chemical engineers with 1-8 years of experience.

AVISCO

Send resumes to:
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Offers immediate long range opportunities for

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***Chemical—Mechanical***

Qualifying Process or Project experience in Refinery, Chemical, Petro-Chemical, or related process plant design preferred.

Liberal relocation allowances for you and your family.

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Prominent manufacturer of centrifugal and filtration equipment has attractive positions available for 2 experienced DESIGN ENGINEERS. An outstanding opportunity exists for a man who has had heavy experience in the design and development of industrial liquids-solids separation equipment. Preferred age: 35 to 50. Continuing expansion of product lines has also created an opening for a graduate M.E., under 35, who has had some experience with separation equipment and can assume project responsibility. These positions will provide attractive salaries commensurate with previous experience, plus important insurance and pension benefits. Please send resume to Personnel Dept. All replies held in strict confidence.

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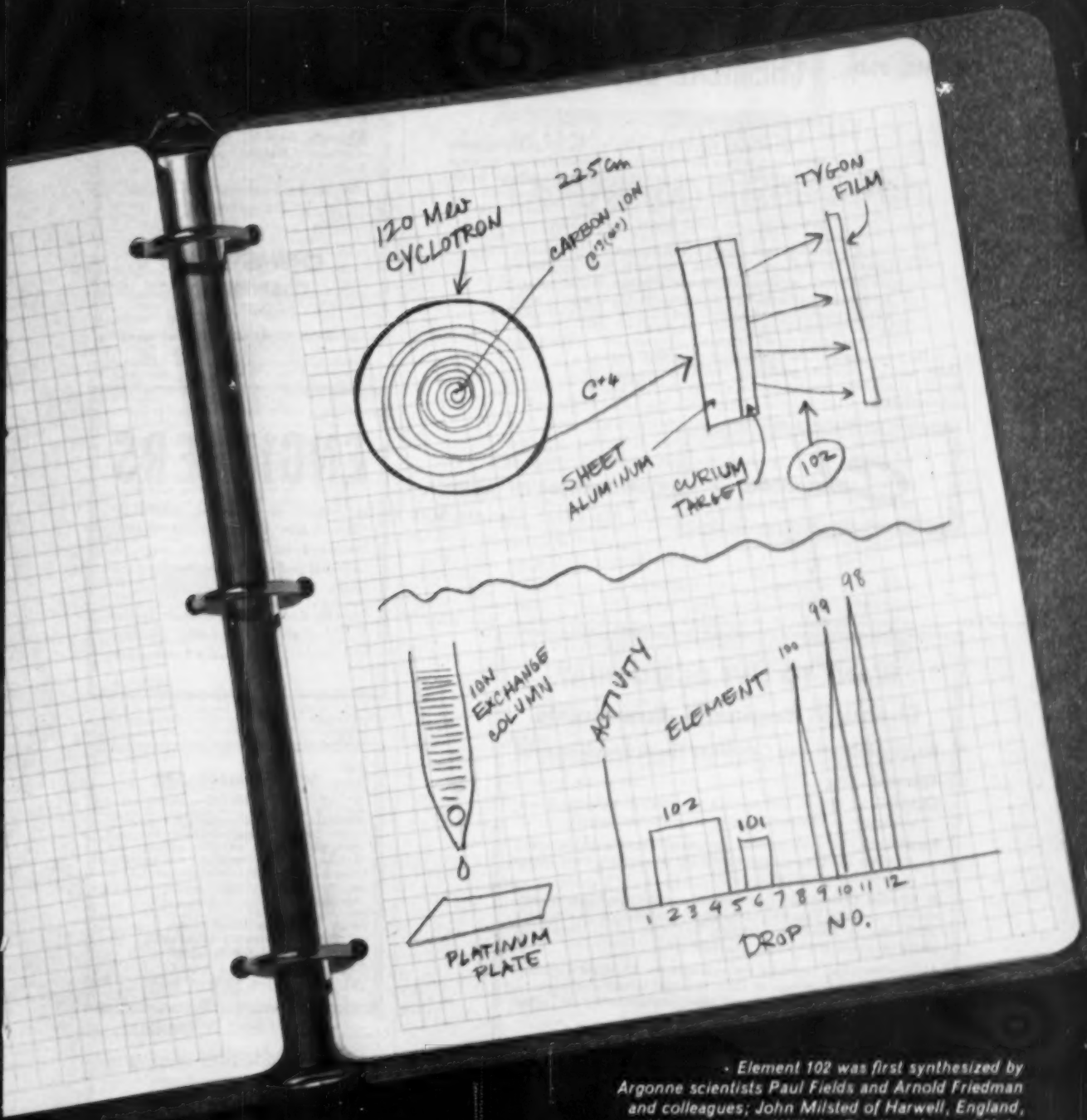
**TRAINEES FOR PROCESS EQUIPMENT SALES**

As part of our expansion program, we have openings for one or more Chemical Engineers with a few years process experience who desire to make a career in sales. Training will involve handling sales correspondence, working in laboratory and pilot plant, starting up equipment in customers' plants and performing service work. At end of training period, man selected will have opportunity for outside sales work on an exclusive territory basis.

Wonderful opportunity for qualified engineers to increase their earning in proportion to their ability and effort.

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• *Element 102 was first synthesized by Argonne scientists Paul Fields and Arnold Friedman and colleagues; John Milsted of Harwell, England, Hugo Atterling, Wilhelm Forsling, Lennart Holm and Bjorn Astrom of Nobel Institute, Sweden*

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Graduate engineers with up to 10 years experience in process development, production or process engineering, capable of independent work on problems in new synthetic fiber spinning operations and in the development of new fiber manufacturing processes and pilot plant operations.

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## Chemical Engineer—Economists

**It's Possible—If You Can Meet These Requirements!**

**Age:** 25-40.

**Education:** BS Degree in Chemical Engineering. Additional economics or business administration studies helpful.

**Experience:** 5-15 years process design, economic evaluation and study of chemical, petro-chemical or synthetic fiber manufacturing operation.

**IF SO**—The Chemstrand Corporation, a major, multi-plant international synthetic fiber producer, which has doubled in size since 1952, has an interesting position for YOU, in it's long-range planning group at PENSACOLA, FLORIDA.

**ALSO**—Interesting positions are available for Chemical Engineers and Mechanical Engineers in plant technical service, maintenance, research and development and design engineering at either DECATUR, ALABAMA, or PENSACOLA, FLORIDA.

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**Technical Personnel Manager**

**THE CHEMSTRAND CORPORATION**

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**NOTE TO A.I.Ch.E. MEMBERS**

If you plan to attend the Baltimore meeting, contact Mr. A. D. Preston, our Technical Employment Representative at the Lord Baltimore Hotel on either Monday, Tuesday, or Wednesday, September 16, 17, 18 for interview appointment.

---

**See Chemstrand's Ad on Page 73 of This Magazine**

*Positions available for*

**ENGINEERS**

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**CHEMISTS**

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**THE CHEMSTRAND CORPORATION**

**Decatur, Alabama**

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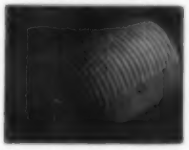

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# news and notes of A.I.Ch.E.

**A unified voice for engineering** is a recurrent theme whenever representatives of more than one engineering field get together . . . how this is to be achieved is the subject of two plans . . . One, advanced by A.I.Ch.E., provides for unification of E.J.C. & E.C.P.D. . . . our members have heard about this . . . The other has been suggested by the American Institute of Electrical Engineers . . . Since this has never been widely publicized to the Chemical Engineers, the complete plan, called the **Coover Plan** after the A.I.E.E. president who advanced it, is presented herewith as it was published in the June, 1957, issue of **Electrical Engineering.**

*"In 1941 AIEE and the other Founder Societies, joined in 1942 by the American Institute of Chemical Engineers (A.I.Ch.E.), formed the Engineers Joint Conference, which in 1945 became the Engineers Joint Council (EJC). Although recognized initially as a Federation of Societies, it was hoped that EJC eventually would develop into a 'Unity' organization of the type for which our membership had expressed a preference; namely, a society based on individual membership, with power to act and adequately financed.*

*"In reappraising this situation, the AIEE Board has reached the conclusion that there is little likelihood in the immediate future of welding the activities of the various technical and professional societies into one 'American Engineering Association' to parallel the American Medical Association (AMA) and American Bar Association (ABA). Accordingly, for the present, the AIEE Board believes that the several established organizations should operate in accordance with the division of activities outlined below, and proposes to furnish moral and financial support on this basis.*

*"1. Electrical Engineering. AIEE to provide the medium for advancement in technology in all branches of electrical engineering and devote its efforts to this end. It is recognized that excellent services are being rendered in specialized areas of electrical technology by other societies. AIEE will cooperate with these societies. If mutually satisfactory arrangements can be effected, AIEE is agreeable to a merger into one organization for economy and coordination of activities.*

*"2. Engineering Other Than Electrical. EJC to provide the medium for co-ordination and co-operation on technological matters transcending the electrical field, and present to the public the position of the engineering profession on technological matters.*

*"For these purposes, a Federation of Societies is adequate. Accordingly the AIEE Board proposes that in the future it will support and participate only in the technical activities of EJC.*

*"3. Engineering Education. Engineers' Council for Professional Development (ECPD) provides the medium for guidance in engineering education (a) during high school preparation, (b) during the undergraduate and postgraduate collegiate periods, and (c) during the 'engineer-in-training' period for a professional career. It could be delegated to represent the engineering profession in all educational matters.*

*"4. Professional Development and Economic Status. National Society of Professional Engineers (NSPE) to provide the medium for the general promotion of the professional aspects of engineering in the eyes of the public, and consequent enhancement of the economic status of engineers. The term 'professional,' as differentiated from technical and educational, is construed to include such activities as registration, employment practices, salaries and fees, legislation, and ethics.*

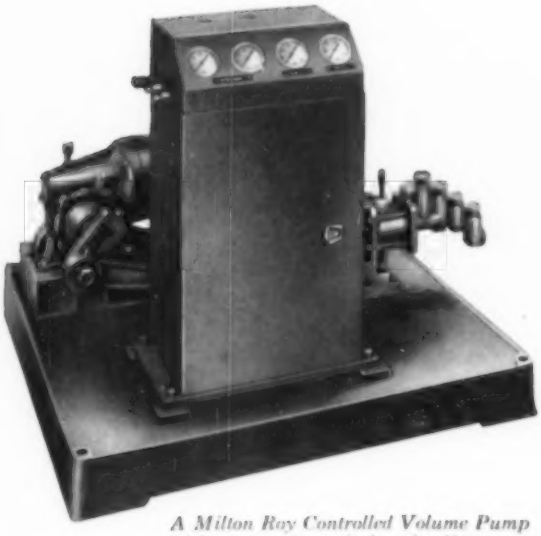
*"5. Co-ordination of Activities. To implement this policy, the AIEE Board proposes that the several activities presently individually sponsored by these organizations be assigned according to the above delineation of scopes;namely, Technological (EJC), Educational (ECPD), and Professional (NSPE). Separation and realignment of activities into these categories could eliminate present confusion and wasteful duplication of effort.*

*"If each of the organizations establishes itself in the fields indicated, it is believed that many of the advantages desired of a 'Unity' organization may be realized. Eventually, it may be possible to incorporate them into one over-all engineering association.*

*"6. Expansion of NSPE. AIEE has for many years recommended to its members that they should take steps to register as professional engineers. NSPE should put itself in a position to represent the profession more completely by expanding its individual membership organization to include as well as registered engineers those qualified members of the profession whose work does not by law require registration. Under such conditions, the AIEE Board proposes to recommend that all its members affiliate with NSPE."*

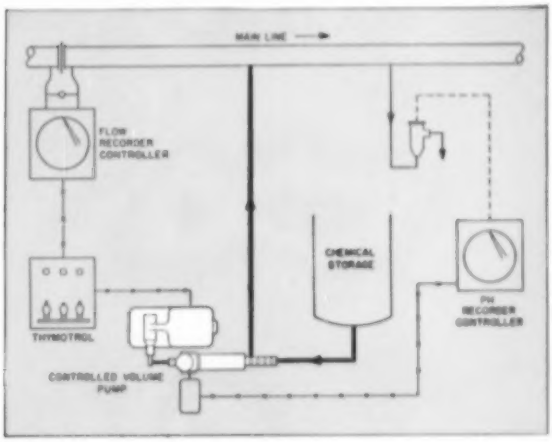
The plan contains elements quite distinct from the **A.I.Ch.E. goal of merging E.C.P.D & E.J.C. as one step toward engineering unity.** In fact, for the chemical engineer, this plan, if carried out, may mean the shaping of a very different sort of chemical engineering society—one devoted only to technical matters & not particularly interested in items such as salary surveys, educational criteria, employment conditions, registration, etc. To put it broadly, it would stop trying to serve the whole man & serve only one quarter of the whole man, allowing E.J.C., E.C.P.D., & N.S.P.E. to serve the other quarters. However, the plan deserves the **careful consideration of Council,** for it represents the approach of another society to the same problem that we are trying to solve.

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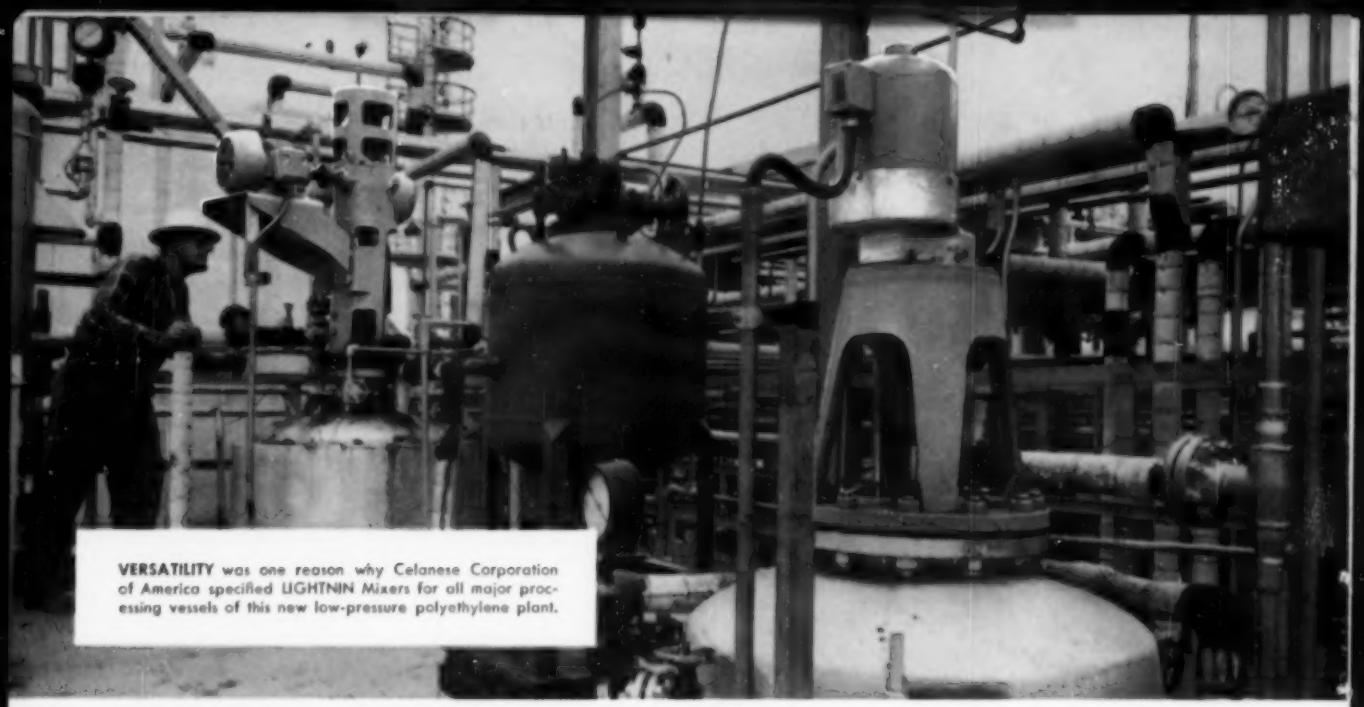
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# *Why Celanese chose these mixers for* low-pressure polyethylene

How can mechanical mixers help you give the touch of success to an important new process?

Celanese Corporation of America faced this question when its Plastics Division designed a plant to produce 100,000 lbs./day of Fortiflex® low-pressure polyethylene.

### Needed: special answers

"We looked for a mixer supplier who could provide special features required by our process," says Lonnie C. Cunningham, chief engineer at the new Celanese plant, Pasadena, Texas. "MIXCO engineers came up with a design that solves these mixing problems for us:

"1. The mixers had to be *versatile*, since they must suspend solids in liquids over a wide range of operating temperatures. MIXCO's experience in our field and similar ones gave us confidence that their design would stand up in actual performance.

### "No stoppage"

"2. *Efficiency* of the mixers means much to us, because any stoppage in our continuous process may cause troublesome settling and hardening of material in the tanks. The durable construction of LIGHTNIN Mixers is important in maintaining uninterrupted flow.

"3. Another factor in keeping this process onstream continuously is the LIGHTNIN *mechanical seal* on some of our pressure units. This seal prevents leakage, and requires practically no maintenance. When necessary, we can change the seal quickly *without dismantling the mixer*, without loss of product and without pulling specially skilled men off other jobs.

"4. Finally, MIXCO's price was competitive—even though their bid was not the lowest."

### Getting the edge

You can give *your* new process economic advantages like these by calling in MIXCO at an early stage.

*You get onstream faster* because MIXCO can build the special-purpose mixers you need, using *standard stock components*.

*You know you're right* because your LIGHTNIN Mixers are designed on the basis of unique fluid mixing experience and technology . . . and backed by a guarantee of successful results.

*You trim operating costs* with mixer features like the LIGHTNIN mechanical seal, flex-protected gearing, and many others.

To see how you can get this efficient kind of mixing for your process, talk to your LIGHTNIN Mixer representative (you'll find him listed in Chemical Engineering Catalog). Or write us direct.

## "Lightnin® Mixers"

**MIXCO fluid mixing specialists**



**MECHANICAL SEAL** on this turbine-type LIGHTNIN Mixer at Celanese can be replaced in minutes without dismantling mixer and without special skill.

**WHAT MIXING OPERATIONS** are important to you? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)

*Check, clip and mail with your name, title, company address to:*

**MIXING EQUIPMENT Co., Inc., 199-j Mt. Read Blvd., Rochester 11, N.Y.**

*In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 10, Ont.*